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FURTHER CLINICAL EXPERIENCES WITH NINETY-FIVE PER CENT OXYGEN FOR THE ABSORPTION OF AIR FROM THE BODY TISSUES*

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WHEN atmospheric air accumulates in excessive quantities in body cavities or tissue spaces, it may become a noxious foreign body causing symptoms varying from a mild discomfort to alarming distress. This is the situation in gaseous distention of the intestine, spontaneous pneumothorax, subcutaneous emphysema, air embolism and the immediate postencephalographic state. The oxygen fraction of the air is rapidly absorbed, but the nitrogen fraction remains as the offending agent. It disappears from the tissues very slowly because its diffusibility into the blood stream depends on the small difference between its partial pressure in the tissues (627 Mm. Hg.) and the blood¹ (573 Mm. Hg.).

The simple expedient of withdrawing the incarcerated nitrogen by needle and syringe can be effectively applied only in the case of pneumothorax. We have, therefore, attempted to effect the removal of the nitrogen indirectly by lowering the tension of the nitrogen in the blood stream. This is readily accomplished by supplanting the ordinary air which is breathed by 95 per cent oxygen. Shaw¹ measured the fall in the partial pressure of nitrogen in the arterial blood during the inhalation of pure oxygen and found that after one hour this pressure is 155 Mm. Hg., after two hours 91 Mm. Hg., after three hours 52 Mm. Hg. and after four hours 31 Mm. Hg. Therefore, when pure oxygen[†] is breathed, the diffusion pressure existing between nitrogen in the tissues and that in the blood progressively increases, so that one should expect a corresponding increase in the speed of absorption of nitrogen from the tissues into the blood stream, whence it escapes into the expired air.

In a previous communication² experimental evidence was offered confirming these theoretic considerations. Cats, whose obstructed intestines were inflated with nitrogen, disposed of only 10 per cent of the original volume of gas when atmospheric air was breathed, whereas about 60 per cent disappeared in the same interval of time when pure oxygen was breathed. Similar,

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† For practical purposes 95 per cent oxygen is adequate.

though not accurately quantitated, results were observed in pneumoperitoneum and subcutaneous emphysema.³ It was pointed out furthermore that the time required to absorb a given volume of nitrogen from any body space "depends on the surface area of the gas bubble, since only that fraction in contact with an absorbing surface can enter the surrounding tissues and from there the blood capillaries. For example, 500 cc. of nitrogen in the intestine, the pleural cavity or the peritoneal cavity will presumably require a considerably greater interval of time for absorption than an equal volume dispersed as tiny bubbles throughout the body, as in caisson disease."

These observations have been applied to patients suffering from intestinal distention and from the symptoms immediately following encephalography. The preliminary results were reported in two recent papers^{4, 5} together with a description of an apparatus for the clinical administration of 95 per cent oxygen.* In this report we are presenting further clinical experiences with 95 per cent oxygen in order to define more clearly its advantages and its limitations for the absorption of air from the body cavities and tissue spaces.

INTESTINAL DISTENTION

Case 1.—Mesenteric Adenitis. Postoperative Distention.—A male, age 12, two weeks before admission to the hospital had had peri-umbilical pain accompanied by nausea and vomiting, which subsided in 24 hours. The same symptoms recurred 11 days later, and the pain this time radiated to the right lower quadrant. At celiotomy the only abnormal finding was acute mesenteric adenitis. One node was removed for biopsy and appendectomy was performed. From the second to the fifth postoperative day he vomited once or twice daily. He passed a slight amount of flatus occasionally but the abdomen became distended and he began to feel peri-umbilical, colicky pain. A duodenal tube was inserted, heat applied to the abdomen and enemata were given, but without relief. There had been only one small bowel evacuation since operation, which was obtained by enema on the third postoperative day. On the seventh postoperative day a scout roentgenogram showed distended coils of small and large intestine. Because of the persistence of colic and progressive distention, he was put into a 95 per cent oxygen tent for 21 hours with the two one-half hour rest periods out of the tent for feeding. The following observations were made during the oxygen inhalation period.

TABLE I
ABDOMINAL GIRTH IN CENTIMETERS AT VARIOUS LEVELS

	Xiphoid	Umbilicus	Midway from Umbilicus to Pubis	Remarks
11:00 A.M.	66 cm.	65.5 cm.	68 cm.	Put into 95% oxygen tent
3:30 P.M.	66 cm.	65 cm.	67.5 cm.	Out of tent for one-half hour
7:30 P.M.	65 cm.	64.5 cm.	67 cm.	Passed moderate amount of flatus and small amount of feces. Out of tent one-half hour. Abdomen softer
8:00 A.M.	62.5 cm.	62 cm.	64 cm.	Spontaneous and adequate bowel movement. Abdomen soft and collapsed

All pain and vomiting ceased, the abdomen remained soft, he passed gas freely and had normal evacuations thereafter.

* This has since been modified by Schwab,⁶ and more recently by Burgess.⁶ Both modifications have the considerable advantage of dispensing with the motor unit for

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COMMENT.—The vomiting, colic, distention and failure to have bowel evacuations suggested mechanical obstruction. On the 7th postoperative day 95 per cent oxygen was administered as a final measure before resorting to enterostomy. The prompt and permanent relief of all symptoms, associated with the effective deflation accomplished, after all other measures were unavailing, lend clinical support to the experimental observation that 95 per cent oxygen is an effective agent for decompressing the intestine distended with gas.

The smooth convalescence after the oxygen inhalations indicates that we were not dealing with established mechanical obstruction. Presumably the oxygen inhalations decreased the intraluminal tension of the overstretched intestine sufficiently to allow the intestinal muscle to recover enough tone to effect an adequate evacuation.

That deflation of the bowel can be accomplished even in the presence of an organic obstruction is demonstrated by the following two cases.

Case 2.—*Obstructing Carcinoma of the Sigmoid.*—A female, age 75, was referred to the hospital for complete proctidentia. She gave a history of lower abdominal colicky pain of four weeks' duration with increasing constipation and anorexia. For four days preceding entry there had been no bowel evacuation in spite of enemata and purgatives. Vomiting occurred once. Examination showed an emaciated, dehydrated elderly lady, complaining of occasional lower abdominal pain. There were râles and suppressed breath sounds at the lung bases, arteriosclerosis, and a blood pressure of 165/95. The abdomen was generally tender and markedly distended, particularly in the lower half. There was moderate audible, but no visible, peristalsis. A soap suds enema resulted in only a little flatus.

Because of her age and precarious condition, she was placed in a 95 per cent oxygen tent preliminary to performing cecostomy. She was kept in the tent for a total of 34¾

TABLE II
ABDOMINAL GIRTH IN CENTIMETERS AT VARIOUS LEVELS

	Xiphoid	Umbilicus	Midway from Umbilicus to Pubis	Remarks
5:00 P.M.	78 cm.	82 cm.	81 cm.	95% oxygen started
12:30 A.M.	74 cm.	78 cm.	79 cm.	Abdomen much softer. Passed a little flatus. Out of tent for one-half hour
8:00 A.M.	72 cm.	77.5 cm.	78 cm.	Oil enema with gas and fecal returns
9:00 A.M.	Out of tent
9:45 A.M.	72 cm.	77.5 cm.	78 cm.	Back in tent
12:00 NOON	Out of tent for one-half hour
6:00 P.M.	73.5 cm.	78.5 cm.	81 cm.	
8:00 P.M.	72 cm.	76.5 cm.	77.5 cm.	

circulating the air. Schwab's apparatus utilizes a face mask instead of a hood. This makes it impractical for administration of oxygen over long periods of time but answers the purpose for the treatment of postencephalographic symptoms. The new Burgess tent is an excellent substitute for our original apparatus, but lacks the valuable feature of a washout valve which greatly shortens the time necessary to attain the desired concentration of oxygen.

hours, with occasional interruptions for rest and to avoid the possible toxic effects of continuous, prolonged administration of 95 per cent oxygen. Within seven and one-half hours after starting oxygen there was a marked decrease in abdominal girth. After 15 hours the abdomen was obviously less prominent and the colicky pain had vanished. Enemata were then moderately successful, especially for flatus. Although the maximum decrease in girth was obtained at the end of 34¼ hours, the bulk of the effect was secured after the first 15 hours of oxygen administration.

At the conclusion of the experiment the patient was entirely comfortable and seemed, clinically, so much improved that the apparent need for decompression at the time of admission was obviated and a more leisurely and adequate preoperative study and preparation were made possible. Enemata continued to be effective. On the fourth day after entry, a barium enema showed obstruction in the sigmoid, following which cecostomy was performed for obstructing scirrhus carcinoma of the sigmoid.

COMMENT.—This case is a clear demonstration of the efficacy of 95 per cent oxygen inhalations to deflate a bowel distended with gas. The decrease in abdominal girth was considerable before any substantial amount of flatus was expelled, indicating that the result was effected largely by the absorption of nitrogen from the bowel into the blood.

Case 3.—*Perforated Gangrenous Appendicitis, Peritonitis, Postoperative Mechanical Ileus.*—A male, age 42, following excision of a gangrenous appendix and drainage of the accompanying peritonitis, became distended in spite of passing small amounts of flatus during the first three postoperative days. Eserine sulphate, heat to the abdomen and repeated enemata failed to prevent increasing distention. An intragastric tube discharged large amounts of green fluid and some gas. On the fourth postoperative day the inhalation of 95 per cent oxygen was started and continued for 18 hours with interruptions, totaling one and one-half hours. During this period of exposure to oxygen, no gas was passed by rectum. The following table shows the course of the abdominal distention.

TABLE III
ABDOMINAL GIRTH IN CENTIMETERS AT VARIOUS LEVELS

	Costal Margin	Umbilicus	Midway from Umbilicus to Pubis	Remarks
4:20 P.M.	90.5 cm.	89.5 cm.	89.8 cm.	Oxygen started. Abdomen very tense
9:00 P.M.	91.5 cm.	89 cm.	92 cm.	
12:00 P.M.	90 cm.	87 cm.	94 cm.	
1:00 A.M.	91 cm.	87 cm.	91.5 cm.	Abdomen softer
2:30 A.M.	91 cm.	88 cm.	91.5 cm.	
6:00 A.M.	90 cm.	86 cm.	88.5 cm.	Abdomen softer. Patient more comfortable
9:00 A.M.	88 cm.	85 cm.	88.5 cm.	
10:30 A.M.	88.5 cm.	85.5 cm.	88.5 cm.	

The final measurements show a maximum reduction in girth at the umbilicus of 4 cm., but the actual decrease in distention is not accurately reflected in the figures. The abdomen during the first eight hours was very tense and although the measurements at 1 A.M. show no obvious reduction, the abdomen had become quite soft and the patient more comfortable. At the close of the period of oxygen inhalation, enterostomy was performed for acute intestinal obstruction. The small intestine was edematous *but not distended with gas*. Large amounts of free fluid in the peritoneal cavity accounted in part for the degree of distention originally presented. Following operation all symptoms rapidly subsided and an uncomplicated convalescence ensued.

COMMENT.—During the period of exposure to oxygen no intestinal contents escaped by rectum, while some ten ounces of fluid and little or no gas were recovered from the stomach tube. The decompression is, therefore, attributable to absorption of at least part of the distending gases by the use of the oxygen tent.

The resulting fall in intraluminal tension may have released the intestinal circulation above the point of obstruction sufficiently to facilitate partial absorption of the accumulated fluids as well. Although we have no direct clinical evidence for this assertion, the experimental data at hand are adequate.² To a large extent, therefore, the 95 per cent oxygen tent differs from an enterostomy tube only in that the rate of decompression is slower.

We do not wish to imply from the experience with the cases detailed so far that the 95 per cent oxygen tent should be utilized as a routine preoperative measure in all instances of mechanical ileus. But it is perhaps not too bold to suggest that by its use an enterostomy may be obviated altogether in *mechanical obstruction of a transitory nature*. The evanescent character of the obstruction in many cases of generalized or localized peritonitis, in which release of the intra-intestinal tension by enterostomy is frequently all that is necessary, is familiar enough. It is precisely in this sort of situation that the oxygen method may provide a valuable substitute or at least serve as a palliative during the period of indecision as to the mechanical or functional nature of the distention. By way of illustration we cite the following two cases:

Case 4.—*Perforating Appendicitis with Peritonitis.*—A male, age 3, had complained, six days previous to admission, of peri-umbilical pain and was given castor oil. Pain and vomiting persisted until entry. Physical examination showed a toxic, dehydrated, cyanotic child with generalized abdominal spasm and distention. A gangrenous appendix was removed and an extensive pelvic peritonitis drained. There was steady improvement with gradual decline in temperature and pulse rate until the sixth postoperative day, when marked distention recurred together with fever and tachycardia. A bulging mass presented in Douglas' pouch. No gas could be passed by rectum with the aid of the usual measures. After eight hours in the 95 per cent oxygen tent he suddenly passed a large amount of flatus and had a copious bowel evacuation, with immediate softening of the abdomen and a reduction of 6 cm. in abdominal girth. Steady improvement followed and the pelvic mass resolved spontaneously.

COMMENT.—The point of view that the deflation secured was not necessarily a result of the oxygen inhalations cannot be controverted; but it loses plausibility in view of the fact that in practically all cases in which the method has been tried, the same result has been uniformly obtained.

Case 5.—*Bilateral Tubo-Ovarian Abscesses, Pelvic Peritonitis, Bilateral Bronchopneumonia.*—A female, colored, age 39, entered the hospital with a chief complaint of abdominal pain and swelling. Her past history was unimportant except that her first two children had died in infancy and her third pregnancy terminated in a miscarriage. Two weeks before admission she contracted a cold, which was accompanied by a dry, hacking cough. Shortly thereafter she had severe epigastric pain which later shifted to the lower abdomen. The abdomen became swollen and breathing increasingly difficult. Anorexia, constipation and dysuria followed and persisted for the week preceding

entry. Although she took fluids during the 48 hours previous to admission, she vomited several times and passed no gas or feces. Physical examination showed an acutely ill, obese Negro woman, markedly dyspneic, with evidence of bilateral bronchopneumonia and severe distention of the abdomen, which was rigid and tympanitic throughout. Both lower quadrants were tender. Pelvic examination showed diffuse tenderness and a profuse vaginal discharge. The white blood count was 23,000. The temperature, pulse and respiration were elevated.

The clinical picture of bronchopneumonia, peritonitis and distention, due either to a functional or mechanical ileus, was rather desperate. Immediate celiotomy seemed to involve too grave a risk. An enema yielded no flatus or fecal results. An intragastric tube was introduced and fluids given parenterally. She was put into a 95 per cent oxygen helmet for the relief of the distention as well as for the respiratory distress. Table IV summarizes the results.

TABLE IV
ABDOMINAL GIRTH IN CENTIMETERS AT VARIOUS LEVELS

	Costal Margins	Umbilicus	Midway from Umbilicus to Pubis	Remarks
12:00 P.M.	100 cm.	105 cm.	107 cm.	Oxygen started
8:00 A.M.	105 cm.	105 cm.	106 cm.	Removed from tent for two hours
6:00 P.M.	103 cm.	106 cm.	108 cm.	Removed from tent for one and one-half hours
7:00 A.M.	99 cm.	102 cm.	104 cm.	<i>Passed large amount of flatus for first time in 96 hours.</i> Abdomen quite soft. Patient much more comfortable

Following the period of oxygen therapy, operative exploration of the pelvis disclosed bilateral, acute and chronic tubo-ovarian abscesses with multiple fresh and old adhesions to surrounding structures. Convalescence was marked by a productive cough, but there was rapid decline of the fever and tachycardia; the dyspnea abated, vomiting stopped, fluids and food were taken freely and gas and feces were passed without difficulty. Distention did not recur.

COMMENT.—Although measurements of abdominal girth show a final decrease of 3 cm. at the umbilicus after a total of 27½ hours of exposure to 95 per cent oxygen, there was a noteworthy increase in girth at various levels during the first 18 hours. This seems to contradict our belief that oxygen was beneficial, at least for that period. However, as already suggested in connection with a similar experience in Case 3, the measurements of girth, when the abdomen is tense, do not accurately reflect the actual degree of intestinal distention. As the restricting effect of a tight musculature gives way, the viscera displaced upward into the thoracic cage and downward into the pelvis recede to their more usual positions and the compressed intestinal coils expand, so that for a time at least during the period of effective oxygen therapy the abdominal girth may actually increase.

DISCUSSION.—We offer the foregoing data as further support for the adoption of the 95 per cent oxygen tent method for the treatment of intractable gaseous distention of the intestine. It is not possible to predict the percentage of successes or failures involved by the use of this method with-

out a much more extensive experience. The consistently satisfactory results secured in the patients referred to in the previous report,⁴ as well as those cited in the present communication, lead us to believe that a high average of successes can be obtained if the proper technic is adhered to.

The fear of toxic effects from prolonged periods of breathing pure oxygen, reported by Binger⁷ and a number of other investigators, does not constitute a valid objection to the method for several reasons: (1) The nursing requirements of patients make interruptions in administration of oxygen necessary. Such interruptions, averaging one-half hour in every four to eight hours,* constitute a sufficient factor of safety, as is amply demonstrated in experimental studies⁸ and in our experience with patients. There has not been a single instance in which the faintest suggestion of oxygen poisoning appeared. We have given 95 per cent oxygen intermittently for as long as 35 hours, but much shorter periods will ordinarily suffice for the desired result. (2) Should future experience fail to sustain our belief that the method is without danger, the substitution of Barach's oxygen-helium mixture,⁹ which is likewise a respirable gas containing no nitrogen, would obviate this objection.

The simplest types of intractable distention for which the method may be utilized are the postoperative, functional types and those associated with pneumonia or cardiac disease. In addition, the distention of peritonitis is a particularly appropriate type for its application. Brown¹⁰ aptly points out that the disturbed function of the gastro-intestinal tract in peritonitis may be as inimical to recovery as the peritonitis itself. If overdistention can be avoided or minimized by an agent which is more directly effective than those in current use, we may be in a position to treat peritonitis with more success than heretofore.

If the distention is due to established mechanical obstruction, there is no choice but to perform an enterostomy. Aside from relieving the excessive tension in the blocked loop by enterostomy, operation provides the only certain method of determining the nature of the obstruction. The possible presence of strangulation makes immediate surgery obligatory regardless of the surgical risk. When, however, there is good reason to believe that strangulation is not present, the element of surgical risk may justify withholding immediate operation if a useful alternative exists which will, at least temporarily, efficiently decompress the bowel. In these circumstances the inhalation of 95 per cent oxygen should find its place.

We have used the intragastric catheter routinely during the administration of oxygen in order to prevent the entrance of air or oxygen into the duodenum. In no instance was it possible to attribute any substantial portion of the deflation accomplished to the amount of gas discharged through the catheter.

The suction method of Wangensteen has its own important indications, but it is doubtful if it can be confidently relied upon in low obstructions to

* Periods of rest out of the tent, unless unavoidable, should ordinarily not exceed one-half hour because the longer the patient breathes atmospheric air the more nitrogen enters the blood from the lung and the longer is the subsequent interval in the tent in order to desaturate the blood of its nitrogen.

deflate the bowel just above the block, which is the part in most urgent need of it. Nor can a suction tube answer the needs of a case in which more than one level of obstruction exists, such as may occur in peritonitis. In this instance, as in any closed loop obstruction, the commonest example of which is obstruction of the colon, the choice rests between an enterostomy or 95 per cent oxygen administered through a helmet. To the extent to which a suction tube, like an enterostomy tube, removes fluid directly, it is probably superior to the oxygen method, which can only do so indirectly by improving the absorptive capacity of the bowel after partial deflation. A combination of both methods applied simultaneously should provide the maximum benefit which each has to offer.

In long standing obstruction the bowel musculature is occasionally so paralyzed from overstretching that enterostomy fails to result in prompt evacuation. Cheever¹¹ and others have, therefore, been led to eviscerate the gut and express the retained fluids and gas at the time of enterostomy. There are those who feel that this is a heroic procedure fraught with danger. In the controversy concerning the relative merits of rapid versus slow decompression, a middle ground may be taken by performing the enterostomy and supplementing it with the administration of 95 per cent oxygen. If the enterostomy fails to function, the oxygen tent will at once initiate gradual deflation and permit a more rapid recovery of muscle tone than might occur spontaneously. If the enterostomy functions too well, according to those who fear the effects of too sudden decompression, the tube can be clamped, gradual deflation accomplished more gradually by the oxygen tent, and the tube opened at a less critical period thereafter.

SPONTANEOUS PNEUMATHORAX. MEDIASTINAL EMPHYSEMA.

Expansion of the lung after spontaneous pneumothorax can occur only after the point of rupture is healed. Until then withdrawal of air by needle and syringe from the pleural cavity is the simplest and most effective way in which to relieve the pressure effects of pneumothorax.

In a previous paper³ we stated that "in the case of valvular pneumothorax or mediastinal emphysema, . . . for which the method (95 per cent oxygen inhalation) might be utilized, we encounter a different situation than in instances of completely closed spaces containing air, in that the volume of gas entering the pleural or mediastinal space is not a limited quantity, but continues to increase as long as the point of entrance of air remains open. Substituting pure oxygen for air as the respiratory gas would result in the absorption of the nitrogen, but its immediate replacement by the entrance of oxygen through the defect would offer no advantage in counteracting the pressure effects of the gas, unless the rate of entrance of the oxygen through the defect were no greater than its rate of absorption by the tissues." The following cases are illustrations in point.

Case 6—*Ruptured Emphysematous Bleb? Valvular Pneumothorax.*—A male, age 56, with a history of chronic productive cough for 30 years, was suddenly seized with

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severe dyspnea while climbing stairs, five months before admission. He remained dyspneic and bedridden seven weeks. Thereafter he was able to be up, but walking a block or two caused breathlessness. He entered the hospital with the complaint of dyspnea on exertion. Physical examination showed a dyspneic and orthopneic patient with a right-sided pneumothorax. This was confirmed roentgenographically, which showed collapse of the entire right lung. The remainder of the history and physical examination was negative or irrelevant. The cause of the pneumothorax was considered to be due either to an acid fast bacillus infection, for which there was insufficient evidence, or rupture of an emphysematous bleb.

The special feature of the case was the persistence of the pneumothorax for five months. Failure of the lung to reexpand after such a long interval implies that the original point of rupture had not healed. If this be true, the oxygen in the air of the pleural space should approximate the oxygen content of alveolar air, which is 16 per cent. A gas analysis of a sample from the first 500 cc. of air withdrawn gave the following results: Oxygen 3.2 per cent, carbon dioxide 8.8 per cent, nitrogen 88 per cent—proportions more nearly those ordinarily found in tissue spaces or what might be expected in a closed pneumothorax. But a closed pneumothorax of this duration should have allowed sufficient readjustment of cardiorespiratory mechanics to banish the dyspnea. Furthermore, even if the collapsed lung had become "hepatized" or resisted expansion because of a viscid intrabronchial secretion, collapse of the chest wall, elevation of the diaphragm or ipsilateral displacement of the mediastinum should have occurred; but none of these was present according to the roentgenographic evidence. The apparent contradiction of facts could be reconciled only on the assumption that a leak, probably of a valvular type, must still be present but too slow to reflect the higher oxygen content of alveolar air.

Roentgenographic examination immediately after the removal of the first 500 cc. of air, and on the next day of 900 cc., failed to show any expansion of the lung. The patient, nevertheless, experienced subjective relief from dyspnea. In these circumstances further withdrawal of air seemed worth trying, but the immediate withdrawal of the air, or even a large fraction, might tear and enlarge the original hole causing the pneumothorax. Precaution to avoid this hazard suggested the use of 95 per cent oxygen to facilitate a gradual and uniformly distributed expansion of the lung. Accordingly, the patient was given seven hours of continuous inhalations of 95 per cent oxygen; but only a very slight expansion of the middle lobe resulted. The insignificant effect on the volume of air in the pleural space produced by seven hours of oxygen therapy was not surprising, for although such a period of exposure to oxygen should give a measurable result in the intestine or in the subarachnoid space, the pleural cavity, like the stomach, offers a comparatively poor surface area per unit volume of nitrogen for absorption.*

The oxygen content of the intrapleural air after the seven hour oxygen period rose from 3.2 to 4.3 per cent. Such an increase in oxygen percentage is consistent with a very slow leak, but it might also be consistent with a rise in oxygen saturation of the tissues as a result of breathing pure oxygen for seven hours. Lacking clinical data on this aspect of the problem of gas diffusion, we proceeded as follows: With the patient breathing atmospheric air, 2,000 cc. of air were withdrawn by needle and syringe from the pleural cavity. Gas samples were taken for analysis during withdrawal of the 2,000 cc. of air, at one-half hour, one hour, and two hours afterward, with resulting oxygen concentrations of 3.3, 3.6, 6.78, and 7.5 per cent, respectively. We should now have been convinced of the presence of a leak had not a hissing sound been heard near the occluded needle left in place during these observations. That the leak, if present, was in fact a

*In a previous paper² calculation of the relative surface areas of the stomach and small intestine showed that the latter has an absorbing surface ten times that of the stomach. Consequently a seven hour effect from 95 per cent oxygen on gases in the intestine would theoretically require 70 hours for the same result on gases in the stomach. In this respect the pleural cavity is analogous to the stomach.

slow one was suggested by a roentgenogram which showed, for the first time, a substantial expansion of the right upper lobe.

Ninety-five per cent oxygen was then administered for 17 hours, with a further, though negligible, increase in the expansion of the upper lobe. The expansion persisted for the following 24 hours and the relief of the dyspnea, at rest, was almost complete. It was decided to attempt a gradual and evenly distributed additional inflation of the lung by withdrawing 2,000 cc. of the residual air in increments of 500 cc., and simultaneously replacing it with equal increments of pure oxygen. Complete expansion of the upper lobe and partial expansion of the middle lobe resulted, and the vital capacity increased from 1.1 to 1.8 liters. Since the patient was free of dyspnea and was for the first time able to be up and about without respiratory discomfort, nothing further was done. Should the last procedure have failed to improve the symptoms, we had intended repeating it after first desaturating the blood of its nitrogen by administration of 95 per cent oxygen for several hours. The patient remained well with moderate activity out of bed for the next five days, but roentgenographic examination on the day of discharge showed partial recollapse of the right upper lobe. He remained active and free of discomfort for the next four weeks only to relapse to a state of dyspnea on mild exertion. The evidence is therefore clear that this is a case of valvular pneumothorax with a very slow leak.

COMMENT.—The details of this case demonstrate the correctness of the argument presented in the introductory paragraph of this section. We were only partially successful in expanding this patient's lung because the leak was still present after five months. The slowness of the leak made possible whatever temporary improvement we did secure. The oxygen inhalations did not, and could not, be expected to produce a significant expansion of the lung.

In another case of recent spontaneous pneumothorax, oxygen inhalations proved quite useless because the leak was far too great. Within 20 minutes after applying the oxygen helmet, a gas sample from the pleural space showed 88 per cent oxygen, indicating the futility of attempting reexpansion of the lung by oxygen. For the same reason the method proved futile in the following case of mediastinal emphysema.

Case 7.—*Mediastinal Emphysema, Bilateral Pneumothorax, Subcutaneous Emphysema, Foreign Body in Bronchus, Ruptured Bronchus.*—A female, age 3, aspirated a nut into her trachea the night before admission. At entry into the hospital she had wheezing respirations, and a roentgenogram showed hyperventilation of the left lung. Bronchoscopy for extraction of the nut from the left primary bronchus was followed by normal respiratory function of the left lung, but several hours later subcutaneous emphysema of the head and neck, and shortly thereafter of the entire body, appeared. The temperature rose to 102° F., the respirations varied from 40 to 60 per minute and the pulse rose to 160. She became cyanotic and was placed in a 95 per cent oxygen tent with prompt relief of the cyanosis but not of the dyspnea. The following morning the temperature was 105° F. and roentgenographic examination showed extensive, bilateral pneumothorax. The subcutaneous emphysema involved the whole body and was extremely tense. Immediate aspiration of the air from the left pleural space resulted in prompt relief of the dyspnea. Another roentgenogram showed considerable reexpansion of both lungs. The subcutaneous tissues, which up to this moment had remained very tense, immediately and dramatically softened. It was obvious that the leakage of air from the presumably ruptured bronchus was far too great to make the oxygen inhalations of any value except for the relief of the cyanosis. Excellent oxygenation of the tissues was evident, so that the tent was continued in use. To prevent reaccumulation of air in the pleural spaces a trocar was inserted into the right pleural cavity, through an inter-

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costal space in the axillary line, and connected to a rubber tube, the end of which dipped slightly beneath the level of a column of water. Within 12 hours the patient's temperature fell to 100° F. and the pulse to 130. Careful attention to the one-way water valve resulted in satisfactory clinical improvement for 24 hours, following which the trocar became obstructed and the temperature again rose to 105° F. Readjustment of the trocar was followed by an immediate fall in temperature to 100° F., the pulse to 120, and the respirations to 30. She seemed to be doing extremely well thereafter taking food, talking, etc. The temperature, pulse and respirations did not rise markedly. She was taken out of the oxygen tent at intervals with no resulting discomfort. On the third night the child became cyanotic while out of the tent and died suddenly.

COMMENT.—This is an instance of mediastinal emphysema so fulminating in character as to preclude any possibility of help by 95 per cent oxygen. There was no effect whatever on the pneumathorax or the subcutaneous emphysema until a vent for the steadily accumulating air was made. The oxygen tent served only to oxygenate the blood more effectively than might have been possible in the ordinary oxygen tent. It had the additional advantage over the latter, as already described in a previous paper, that by enclosing the head and neck only, the chest was accessible for nursing and special procedures such as thoracotomy without depriving the cyanotic patient of a constant supply of oxygen.

The striking fall in temperature, after release of the incarcerated air in the chest and subcutaneous tissues, suggests that the fever may have been caused by inability to dissipate heat (1) via the expired air, owing to the pneumathorax; and (2) via the skin, owing possibly to interference with the circulation of the skin and subcutaneous tissues by the high tension of the gases in the interstitial spaces.

POSTENCEPHALOGRAPHIC SYMPTOMS

Following encephalography most patients experience a variable degree of headache, nausea and general indisposition lasting from 24 to 72 hours. The disability may be severe and even prostrating. Such patients form ideal subjects for the clinical evaluation of the theoretic principles underlying the mechanism of the action of 95 per cent oxygen for the absorption of air from tissue spaces. The air consists of a fixed volume distributed over a surface area (the cortical subarachnoid space and ventricles) which is relatively large for the amount of air requiring disposal, as compared with such conditions as pneumathorax or even gaseous distention of the intestine.

Following is the first instance in which 95 per cent oxygen was tried for postencephalographic headache.

Case 8.—Epilepsy. Postencephalographic Headache.—An epileptic girl, age 26, had an air injection into the spinal subarachnoid space for encephalography at 2:00 P.M. May 24, 1935. Sodium amytal effected sleep for three hours, then she awoke with severe headache which persisted in spite of opiates. At 11:45 A.M. the following day, while still suffering with violent headache, she was placed in a 95 per cent oxygen helmet. Thirty minutes later she felt much relieved and two hours later the headache had completely disappeared.

COMMENT.—After this experience Schwab, Fine and Mixer⁵ studied the results of oxygen therapy in 37 cases. Although not all patients were uniformly and completely relieved of the distressing symptoms caused by the air injection, the beneficial effects were sufficiently striking to justify adoption of the procedure as a routine therapeutic measure.

A maximum of three hours of exposure to 95 per cent oxygen inhalations suffices for the absorption of the bulk of the injected air, as shown by roentgenograms before and after the administration of the oxygen. There is a simultaneous disappearance of headache and nausea. The prophylactic use of 95 per cent oxygen results in either complete or partial avoidance of these symptoms. A slight headache and mild nausea may persist in some instances, but, as a rule, the patient is fit and able to be up within 24 hours, which is distinctly shorter than is the case for patients who are not given oxygen.

This procedure has been considered unnecessary by those utilizing oxygen instead of air for encephalography. It is unfortunately not always possible to avoid the postencephalographic syndrome by the use of oxygen, because nitrogen enters the subarachnoid space and the ventricles from the blood during the time required for the absorption of the oxygen.³ Schwab *et al.*⁵ have demonstrated the value of breathing oxygen even when oxygen is employed as the visualizing medium. It is possible, however, that the extremely rapid diffusibility of the anesthetic gases recently advocated by Aird,¹² or of the oxygen-helium mixture of Barach, may supplant pure oxygen or atmospheric air as the visualizing agent. To the extent to which these newer agents may succeed in avoiding the postencephalographic symptoms, inhalation of 95 per cent oxygen will be rendered unnecessary.

AIR EMBOLISM

Death from air embolism is due either to obstruction of the pulmonary capillaries from air entering the great veins in the neck or chest, or to air entering the coronary or cerebral arteries from pulmonary veins, severed or torn, during intrathoracic operations. To avoid such a catastrophe the only available prophylactic measure is the routine use of the Trendelenburg position suggested by Lilienthal.¹³ On theoretic grounds an approach to the problem might be made by preparing patients, in whom the danger of air embolus exists, so that the nitrogen fraction of the air bubbles shall diffuse out of the blood with the maximum possible speed. This can be done by desaturating the blood of its nitrogen content by the use of a general anesthetic containing no nitrogen, such as cyclopropane and pure oxygen, or by the inhalation of pure oxygen if the operation is performed under local anesthesia. We have, however, failed to prolong the life of cats, who were given a minimal lethal dose of intravenous air, by the preliminary administration of pure oxygen for one hour. Whether oxygen will avail in air embolus into the cerebral or coronary arteries is the subject of a current experimental investigation. We have had no clinical experience with the use of oxygen for this purpose.

CONCLUSIONS

(1) The inhalation of 95 per cent oxygen, according to a technic previously described, provides an effective method for deflation of the distended intestine when other nonoperative measures fail. Ninety-five per cent oxygen is a valuable agent whether the distention is of functional or mechanical origin. In mechanical ileus it may be used to advantage before or after enterostomy is performed.

(2) Ninety-five per cent oxygen is of little or no value for the treatment of valvular pneumothorax or mediastinal emphysema so long as the size of the point of rupture is of any consequence.

(3) Ninety-five per cent oxygen inhalations prevent or relieve the symptoms following encephalography.

(4) None of the patients who breathed 95 per cent oxygen, for the length of time necessary to obtain therapeutic effects, showed any signs or symptoms of oxygen poisoning. Toxicity was avoided by interrupting the administration of the gas every four to eight hours for one-half hour or longer.

(5) The length of time necessary to obtain therapeutic benefit from the administration of 95 per cent oxygen cannot be predicted in any given case. It will vary in accordance with the volume of air to be absorbed and the relative extent of the surface area available for absorption.

BIBLIOGRAPHY

- ¹ Shaw, L. A.: Personal Communication.
- ² Fine, J., Sears, J. B., and Banks, B. M.: The Effect of Oxygen Inhalation on Gaseous Distention of the Stomach and Small Intestine. *Am. J. of Dig. Dis. and Nutrition*, 361, 1935.
- ³ Fine, J., Frehling, S., and Starr, A.: Experimental Observations on the Effect of Ninety-five Per Cent Oxygen on the Absorption of Air from the Body Tissues. *J. of Thor. Surg.*, 4, 635, 1935.
- ⁴ Fine, J., Banks, B. M., Sears, J. B., and Hermanson, L.: The Treatment of Gaseous Distention of the Intestine by the Inhalation of Ninety-five Per cent Oxygen. *ANNALS OF SURGERY*, 103, 375, 1936.
- ⁵ Schwab, R. S., Fine, J., and Mixter, W. J.: The Reduction of Post-Encephalographic Symptoms by the Inhalation of Ninety-five Per Cent Oxygen. *Arch. Neur. and Psychiatry*, 37, 1271, 1937.
- ⁶ Burgess, A. M.: Oxygen Therapy: A Modification of the Box Method Giving Ninety-five Per Cent Oxygen. *New England J. Med.* In press.
- ⁷ Binger, C. A. L., Faulkner, J. M., and Moore, R. L.: Oxygen Poisoning in Mammals. *J. Exper. Med.*, 45, 849, 1927.
- ⁸ Sayres, R. R.: Quoted by Evans, J. H., and Dushordwe, C. J.: Further Observations on Oxygen Therapy in the Treatment of Pneumonia. *Anesth. and Anal.*, 2, 193, 1932.
- ⁹ Barach, A. L.: Use of Helium in the Treatment of Asthma and Obstructive Lesions of the Larynx and Trachea. *Am. Int. Med.*, 9, 739, 1935.
- ¹⁰ Brown, H. P., Jr.: Peristalsis and Peritonitis. *ANNALS OF SURGERY*, 100, 167, 1934.
- ¹¹ Cheever, D.: Operative Evacuation of the Small Intestine in Paralytic Stasis. *New England J. Med.*, 207, 1125, 1932.
- ¹² Aird, R. B.: Experimental Encephalography with Anesthetic Cases. *Arch. Surg.*, 32, 193, 1936.
- ¹³ Lilienthal, H.: *Thoracic Surgery*. 2 vols. Saunders, 1925.

RESULTS IN THE OPERATIVE TREATMENT OF MAJOR TRIGEMINAL NEURALGIA

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TRIGEMINAL neuralgia does not endanger life. Intermittent attacks of severe paroxysmal pain in cheek, lip or tongue, however, interfere with eating or drinking and result in loss of weight and strength. Although sufferers from this condition have hoped that death might bring relief from the pain, and suicide from this cause is not unknown, nevertheless, many persons have enjoyed relative comfort for many years in spite of it. The abrupt remissions of the pain, so characteristic of the seizures, always lead to the hope that they will not recur.

Relief of the pain by surgical intervention becomes, therefore, a question of expediency. The mortality of such an operation must be carefully considered. Following surgery, can the patient be assured of complete relief of pain? What are the possible sequelae of an operation?

In this series the transtemporal approach to the sensory root of the trigeminal nerve has been employed. The late Dr. Charles H. Frazier developed and perfected the practical details of this technic and operated upon the majority of the cases herein recorded. Since he saw no added advantage in the suboccipital approach to the sensory root, the records from this Clinic do not contain a sufficient number of cases operated upon by that technic to permit an opinion relative to comparative results.

The problems to be considered in the surgical treatment of major trigeminal neuralgia are: (1) The operative mortality; (2) the type of operation to be performed; whether the sensory root should be completely or partially sectioned and the motor root preserved or cut; (3) the percentage of post-operative complications, such as keratitis, facial paralysis or diplopia due to injury of the adjacent third or sixth cranial nerves; and (4) the percentage of complete relief of pain without the appearance of annoying paresthesias.

(1) *Mortality*.—In this series the transtemporal, or approach to the sensory root through the middle fossa, was employed in 949 operations upon 925 patients with 13 deaths, an operative mortality of 1.36 per cent. In the first 100 cases in which the sensory root was cut the mortality was 4 per cent. In dividing the whole series into groups of 100, in two of these groups no fatalities occurred, in three the mortality was 1 per cent, and in two, 2 per cent. No fatalities occurred in 286 consecutive cases. In the latest group from 900 to 949, no deaths followed operation.

This operative mortality has been strictly considered. Any patient dying in the hospital, no matter how long after operation, and regardless of the

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cause of death, has been included. Seven cases died of cerebral embolism or apoplexy, three within 24 hours of operation, one on the fifth, one on the sixth, one on the ninth, and one on the fourteenth day postoperatively. Three patients died of postoperative hemorrhage and clot, two from meningitis and one from pneumonia (Table I).

TABLE I
PERCENTAGE OF MORTALITY

949 Operations	925 Patients
13 Deaths	1.36% Mortality

CAUSES OF DEATH

Cerebral embolism.....	7
Hemorrhage.....	3
Meningitis.....	2
Pneumonia.....	1

That more than half of the operative mortalities were the result of cerebral vascular accidents is doubtless due to the fact that 83 per cent of these patients were 50 or over at the time of operation. As we have stated, major trigeminal neuralgia is a condition appearing in the later years of life. However, an operative mortality of 1.36 per cent is evidence that even in elderly people operative relief for the pain should not be refused unless really serious contraindications exist.

(2) *Type of Operation to Be Performed.*—Whether the sensory root should be completely or incompletely severed and the motor root preserved or cut can best be determined when the operative complications are considered. If pain is not referred to the first division, a subtotal avulsion, preserving part at least of the fibers to the ophthalmic branch, is indicated. Frequently cases are encountered where the trigger zone exists in the second or third division of the sensory area but not in the first. To be sure, irritation of this trigger zone causes pain over the eye, but touching the eyebrow or forehead is not followed by pain in the maxillary or mandibular branches. Under such circumstances a subtotal sensory root section will relieve the pain, although anesthesia will not be complete in the skin areas supplied by the ophthalmic branch. The corneal reflex will be preserved.

(3) *Incidence of Postoperative Complications.*—The two most feared sequelae are keratitis in the ipsilateral eye and facial paralysis. Injury to the adjacent third or sixth nerve can occur, although more likely to follow complete or incomplete avulsion of the gasserian ganglion than section of the sensory root. The third and sixth nerves were injured on 24 occasions, or 2.5 per cent. In ten of these cases a complete avulsion of the ganglion was effected so that if the sensory root is attacked behind the ganglion, the percentage of third and sixth nerve involvement falls to 1.1 per cent.

A partial facial paralysis resulted in 33 cases, or 3.4 per cent. The recording of partial facial paralysis has been noted very carefully. Any facial paralysis, no matter how slight, has been noted. All of these cases recovered

completely within a year, 19 of them within three months of operation. Six cases of complete facial paralysis, without recovery, have been observed, or 0.65 per cent.

Two causes for facial paralysis following root section have been suggested.¹ When avulsion of the whole root was practiced, it was believed that either the seventh nerve was damaged at the time the sensory root of the fifth was torn away or that following avulsion a hemorrhage in the pons with damage to the nucleus of the seventh nerve might have occurred. We now believe that stripping the dura from the floor of the skull just in front of the ganglion damages the petrosal vein or nerve. The petrosal vein runs with the facial nerve in its canal. As the dura is elevated to expose the ganglion sheath the vein is torn in the facial canal and hemorrhage occurs compressing the seventh nerve in its passage through the bone. The observation of Gardner and Babbitt² that in a large percentage of these cases of facial paralysis a hemorrhage in the middle ear with blackening of the drum-head could be noticed, supports this impression. The petrosal nerve connects with the geniculate ganglion of the facial nerve. Avulsion of this nerve in elevating the dura damages this ganglion and interrupts the function of the seventh nerve.

Eighty-five instances of keratitis resulted from complete or incomplete section of the sensory root. Fifty-nine instances occurred in 353 cases of complete root section, or 16.7 per cent. In 590 cases of subtotal section of the sensory root 26 instances of keratitis were observed, or 4.4 per cent. In five of these a partial facial paralysis resulted from the operation, preventing closure of the eyelids and rendering the development of keratitis almost inevitable. That the keratitis following complete sensory root section is more severe than when subtotal section is performed is borne out by the fact that in the 59 instances of keratitis following complete section, in 15, closure of the eyelids was necessary to control the ulceration and in six cases enucleation of the eye was necessary because of the extensive infection. In the 26 cases subsequent to subtotal section of the root, no eyes were sacrificed, and in but five was the keratitis sufficiently severe to demand suture of the eyelids. These figures support Frazier's³ contention that incomplete root section would go far toward eliminating keratitis.

TABLE II
THE INCIDENCE OF KERATITIS AND RECURRENCE
AFTER TOTAL AND SUBTOTAL RESECTION OF THE SENSORY ROOT

	No. of Cases	Third Nerve	Sixth Nerve	Seventh Nerve (Partial)	Com- plete	Keratitis	Eyes Lost	Lids Sutured	Recur- rences
Complete sensory section	359	5	13	6	4	59 (2 with 7th N.)	6	15	7 over 7½ yrs.
Incomplete sensory section	590	3	3	27	2	26 (5 with 7th N.)	0	5	44 over 4 yrs.

(4) *Relief of Pain; Paresthesias and Recurrence of Pain.*—Complete relief of the original pain followed 942 of these 949 operations, or 99.2 per cent.

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In seven patients no relief followed complete or incomplete section. These patients had precisely the same pain postoperatively as they had had before operation although complete facial anesthesia had been produced. Obviously, major trigeminal neuralgia was not the cause of the pain. Atypical or minor neuralgia was present and operation should never have been performed. This error in diagnosis can be avoided by injection with alcohol of the appropriate branch of the fifth nerve before operation.

TABLE III
RELATION OF PARESTHESIAS TO TYPE OF OPERATION

	Total Sensory and Motor	Total Motor Spared	Subtotal Sensory and Motor Spared	Subtotal Sensory and Motor Cut	Avulsion Ganglion	Section Second and Third Nerves
	271	67	470	107	15	19
No relief of pain.....	2	1	0	2	1	1
Severe paresthesia.....	16	1	20	3	1	0
Mild paresthesia.....	23	11	48	12	2	0

One hundred thirty cases complained of paresthesias, (13.8 per cent). Ninety-eight of these paresthesias were mild (10.3 per cent), of the type in which the patient was perfectly satisfied with the result of the operation and had complete relief of pain, but noticed the numbness of the face, had a sense of mild temperature disturbance, heat or cold, itching, or a sensation of formication in the anesthetic area. Thirty-two (3.4 per cent), had severe paresthesias, developed a different type of pain in the anesthetic area, usually burning and dull, and were almost as uncomfortable after operation as they were before. Fourteen of these patients developed this trouble within six weeks of operation, 18 within the first year postoperatively. This pain was entirely unlike the former stabbing, lancinating tic pain, but was a fairly continuous burning ache deep in the anesthetic area. Four of these patients were subjected to reoperation upon the sensory root without relief. Fifteen had various operations directed against the sympathetic nerve supply of the face, with very indifferent results. Only one was relieved who had been subjected to a carotid sympathectomy.

Fifty-one cases of recurrence (5.3 per cent), of true major trigeminal pain occurred in this series, seven in 359 cases of complete sensory root ablation (2 per cent), and 44 among 590 patients in whom partial section was accomplished (7.4 per cent). Of the seven cases the recurrence appeared on six occasions in the first and once in the third division. Obviously, recurrence of pain was due to the fact that the operator failed to sever completely all the fibers of the root. In the 44 cases pain reappeared in the first division in 40, in the third in three and in the first and third in one. In the 40 cases the fibers running to the first division were deliberately spared to preserve the corneal reflex and prevent keratitis. Thirty of these cases were subsequently relieved by supra-orbital avulsion and five by reopera-

tion and complete severance of the sensory root. Five were not reoperated upon. The four cases having recurrence in the third or first and third divisions were cases in which the original pain occurred entirely in the second division, and in whom only the middle third of the root was severed. These were relieved by reoperation and complete root section.

In the seven cases of recurrence following what was thought to be complete sensory root section, the pain reappeared on an average of seven and one-half years after operation. In the 44 cases of incomplete sensory root ablation the recurrence occurred on an average of four years postoperatively.

In 17 patients the pain appeared on the opposite side after it had been relieved on the side on which it commenced. These cases are not included as recurrences. Five were relieved by bilateral operation, two by bilateral alcohol injection of the trigeminal branches involved, ten were operated upon on the side where the pain originated and the pain when it reappeared on the opposite side was checked by alcohol block. An average of four years and four months elapsed between the relief of pain upon one side and its onset upon the other, the shortest period being nine months, and the longest 12 years. Nine patients were seen with typical trigeminal neuralgia on both sides. All had a radical operation performed on one side and in seven an alcohol block stopped the pain on the other. No deaths occurred in this series.

This group of patients is particularly important because it emphasizes the fact that bilateral trigeminal neuralgia can be easily and permanently relieved by bilateral operations if the indications arise. The improved technic of subtotal section and preservation of the motor root preserves the integrity of the muscles of the lower jaw and greatly reduces the chances of ocular complications.

The question has been raised whether any sensory fibers might be carried by the motor root. If such fibers were present the preservation of this root might account for subsequent paresthesias in the anesthetic area of the face. In 392 cases in this series, in which the motor root was sacrificed, disregarding for the moment whether the sensory root was completely or incompletely sectioned, there resulted 22 severe and 46 mild paresthesias, or 5.5 and 11.7 per cent respectively. Among 537 cases in which the motor root was spared, again regardless of whether the sensory root was completely or partially sectioned, there were 21 severe and 50 mild paresthesias, or 3.9 and 9.3 per cent respectively. Apparently preservation of the motor root does not increase the frequency of postoperative paresthesias. Certainly for functional reasons every effort should be made to preserve it.

Another important, but unfortunately seldom used, indication for block of the fifth nerve fibers exists besides trigeminal neuralgia.⁴ Malignant disease of the face, mouth or paranasal sinuses may often be a source of severe and constant pain. By an alcoholic injection of the proper branch, or, if the pain be widespread, by section of the sensory root, this pain can be relieved. And if this constant pain be relieved it is amazing how the morale of these patients is improved. They can eat and sleep in comfort; they gain weight and

strength. The insertion of radium needles or fulguration of the cancer does not distress them and they are ready and willing to undergo much more radical treatment. I am sure that several patients rendered free from suffering by trigeminal block owe their final cure to the fact that an extensive and radical attack upon the malignancy was undertaken in an anesthetic area. In 41 cases, sensory root section or intracranial section of the second and third divisions was performed. One death occurred in this series. This group of cases is not included in making up the statistics for the operative results in major trigeminal neuralgia. They are mentioned simply because much unnecessary suffering can be avoided if this use of trigeminal block be kept in mind.

CONCLUSIONS

A review of the operative treatment of major trigeminal neuralgia strongly reinforces the opinion that subtotal section of the sensory root with preservation of the motor root is the procedure of choice. It is true that recurrence of pain can and does occur. But the protection that sparing the ophthalmic fibers affords the cornea, the reduction in the number and severity of post-operative paresthesias, more than makes up for this single disadvantage. If recurrence is noted, it almost always involves the first division. Supra-orbital avulsion is an easy and cosmetically unobjectionable means of relief. When the age and general health of the group of patients suffering from major trigeminal neuralgia is considered, an operative mortality of 1.36 per cent is extremely satisfactory. Little or no reason seems to exist for a refusal to attempt to relieve the pain of even the most debilitated of these sufferers. Temporary relief may first be afforded through an alcohol injection, then, when the patient has been restored to health, permanent relief can be effected by subtotal section of the sensory root.

REFERENCES

- ¹ Dixon, S. F.: On the Course of the Taste Fibers. *Edinburgh M. J.*, 1, 395, 1897.
- ² Gardner, W. J., and Babbitt, J. A.: The Occurrence of Tympanic Hemorrhage Following the Radical Operation for the Relief of Trigeminal Neuralgia. *Ann. Otol. Rhinol. and Laryngol.*, 38, 1040, 1929.
- ³ Frazier, C. H.: Subtotal Resection of Sensory Root for Relief of Major Trigeminal Neuralgia. *Arch. Neurol. and Psychiat.*, 13, 378, March, 1925.
- ⁴ Grant, F. C.: Relief of Pain by Nerve Section. *J.A.M.A.*, 92, 1116, January 12, 1929.

SPASMODIC TORTICOLLIS TREATED BY THE PLASTIC REDUCTION OF MOTOR FIBERS OF THE SPINAL ACCESSORY NERVE

REPORT OF TWO CASES

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DOGLIOTTI,¹ in 1934, published the results of his operative treatment on the facial nerve for spasmodic movements of the facial muscles often referred to as a facial tic. It was his theory that if the facial nerve on the affected side were severed, the central portion carefully split in half, and only one-half of the central end sutured to the entire peripheral end of the nerve, harmful nerve impulses could be reduced by at least 50 per cent. In so doing the nerve-muscle-threshold would be raised and such impulses that did arise would be enough to supply tone to the facial muscles, provide innervation for any of the former movements of expression but not enough to cause disfiguring spasmodic movements. In 1935, he demonstrated that his theory was correct. If this were successful in dealing with the seventh cranial nerve, the question arose: Would it be successful in the case of the eleventh cranial nerve in the treatment of spasmodic torticollis?

The author is well aware of the commonly used operation for torticollis, such as severing the first three anterior and posterior cervical roots together with the intradural section of one or both spinal accessory nerves. This operation is quite a radical procedure and while it is successful in ridding the patient of the troublesome spasmodic movements of the head and neck, it does rob the patient of a large amount of power from head, neck and shoulder movements. One patient subjected to this operation was cured of his torticollis but unable to return to his former work of pressing clothes because of the loss of trapezius power in the right shoulder. It is further proposed that a complete section of the eleventh nerve on one or both sides followed by a partial resuture may not be adequate in every case of spasmodic torticollis, but should be used first since it is a less serious operation and more conservative. The anatomy and operative technic are shown in Figs. 1 and 2.

The eleventh, or spinal accessory nerve, consists of two parts, the accessory part to the vagus, and the spinal portion. The former is much smaller and is distributed to the pharyngeal and superior laryngeal branches of the vagus to supply in part the azygos uvulae, levator palati muscles, and possibly some few fibers continue on to be distributed with the recurrent laryngeal nerve to supply most of the laryngeal muscles. The spinal portion takes its origin from rootlets as far down as the seventh cervical segment of the cord which, in turn, come from the anterior gray substance of the cord. These rootlets join and form a trunk which increases in size as it ascends between

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the dentate ligaments and the anterior roots of the spinal nerves. This portion then enters the posterior fossa of the skull by way of the foramen magnum and leaves by way of the jugular foramen, receiving here a few filaments from the vagal accessory portion of the eleventh nerve. At its exit from the jugular foramen, it passes backward, either in front or behind the internal jugular vein, and descends obliquely behind the digastric and stylohyoid muscle to the upper part of the sternocleidomastoid muscle. It pierces that muscle, and passes obliquely across the posterior triangle, to terminate in

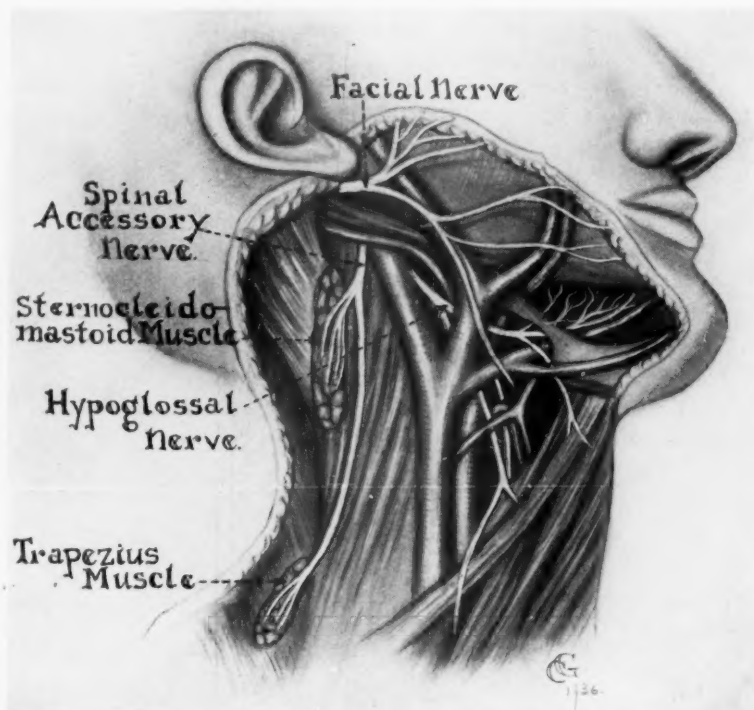


FIG. 1.—Drawing illustrating the anatomic relations of the spinal accessory nerve to the other structures in the neck. (After Wabasse: *Surgical Treatment*, 1, 887.)

the deep surface of the trapezius muscle.² The nerve is exposed and operated upon along that part of its course after leaving the lower border of the digastric muscle and before it enters the sternocleidomastoid muscle (Fig. 1).

CASE REPORTS

Case 1.—St. Vincent's Hospital, No. 15922. A. W., age 39, single, electrician, admitted October 6, 1935, operated upon October 17, 1935, and discharged, improved, October 23, 1935. Diagnosis: Bilateral intermittent spastic torticollis.

The disease began seven years ago and has been progressive, so that it interfered with his work, which consisted of walking along subway tracks to inspect the installation of electrical equipment. There was nothing in his work that necessitated turning his head in any one direction. He used stimulants moderately, and suffered no physical or mental traumata before the onset of the torticollis.

In 1926, two years before the onset of symptoms of torticollis, the patient suffered a severe infection in the left nasal passage which spread to the throat and to both ears

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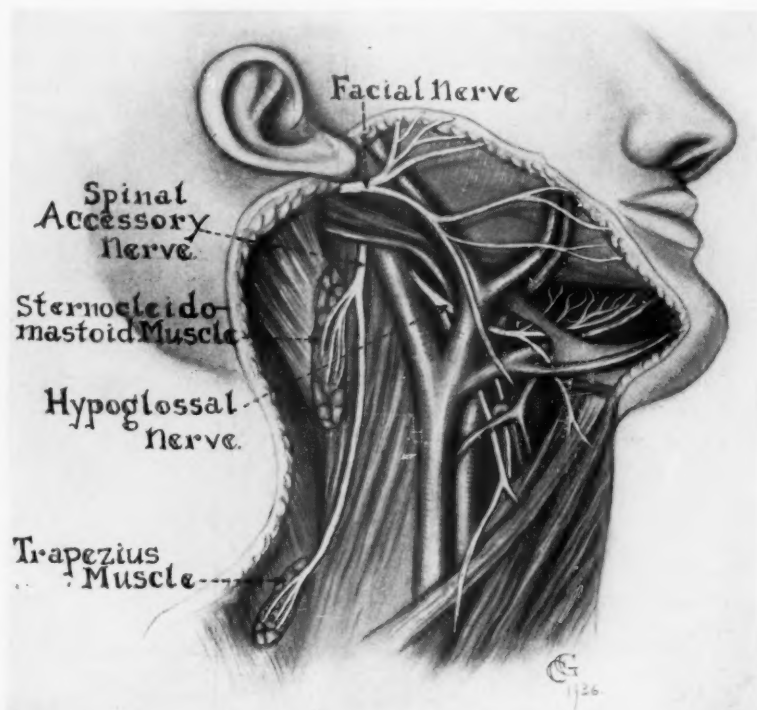


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In 1926, two years before the onset of symptoms of torticollis, the patient suffered a severe infection in the left nasal passage which spread to the throat and to both ears

and eyes. He was ill for five weeks. The type of organism was not ascertained, but if it can be substantiated that the disease has an infectious onset then this widespread infection might be considered a possible etiologic factor of his torticollis. During 1928, slight spontaneous movements of the head to the left occurred daily. They were painless and easily controlled but gradually, after a lapse of three or four years, the spasms became more severe, accompanied with pain in the left side of the neck, and were almost entirely out of his control. A resection of the right sternocleidomastoid muscle, in 1933, did not improve his condition.

Physical Examination, October 6, 1936, showed a robust man lying quietly in bed without distress or pain. There were intermittent involuntary contractions of all the muscles on the left side of the neck and, to a lesser extent, the deep muscles on the right side. Especially upon effort, such as sitting up, talking and walking, irregular movements of the left trapezius and sternocleidomastoid muscle and deeper groups would occur, followed soon by similar muscle groups on the right side. Bilateral involvement was evident with the left side affected first, and subsequently involuntary contractions occurred in muscles of the opposite side of the neck. When in a spasm the occiput was directed toward the left shoulder and the chin upward and to the right. There was a noticeable hypertrophy of the left sternocleidomastoid and trapezius muscles, and a very evident deformity was present on the right side as a result of a previous operation, at which the origin of the sternocleidomastoid muscle was severed. No other neurologic signs were found. A blood count, uranalysis and blood Kahn test were all negative.

A transection of the left, eleventh nerve was proposed with resection of one-half of the proximal end followed by suture of the remaining one-half into the entire peripheral end (Fig. 2B).

Operation.—October 17, 1935: Local anesthesia. Oblique incision on the left side, paralleling the anterior border of the sternocleidomastoid muscle, which was followed downward for a distance of 10 cm. The eleventh nerve was found entering the mesial surface of this muscle. It was traced upward for 3 to 4 cm. and found to consist of the entire trunk of the nerve, determined because of the absence of branches and by the effect of faradic stimulation. The nerve was severed and a portion of the proximal end of the nerve stripped upward. The remaining portion, approximately one-half, was sutured into the entire distal end with five black silk sutures. Thereby, the number of functioning axones entering the peripheral end of the nerve was reduced by one-half.

As a result, there was a paralysis of the left sternocleidomastoid, and an almost complete paralysis of the left trapezius muscle. It is to be noted that the trapezius muscle was not entirely thrown out of function, since the upper cervical nerves also contribute to the innervation of this muscle. According to the patient, after three months, these muscles began to function again.

Follow-up.—July 18, 1936: It was noted that the head was held in a more normal position. He stated that three months after operation there was a noticeable return of power in the left sternocleidomastoid muscle, and that "it would move independently," i.e., rhythmic jerks took place at times but not powerful enough to move his head. The trapezius movements are more powerful and tend to pull the head back a little, so that his chin is held higher than normal. It was planned to carry out a similar operation on the right side to lessen the trapezius pull. However, the patient did not return, as he felt so greatly improved.

Case 2.—Neurological Institute, No. 16685. E. J. S., age 45, married, clerk, was first seen in the clinic, July 14, 1933, complaining of "spasm of the neck and pain in the left shoulder." The onset in May, 1933, was gradual and the course progressive. The contractions were especially noted when walking. A year ago, he became greatly upset, emotionally, upon being discharged from an Insurance Company, where he had been employed for 20 years. This episode certainly furnished a suitable mental background for the development of a functional nervous disease. At this time, while driving

SPASMODIC TORTICOLLIS

a car, he could control the movements of his head and neck by placing his hand on the left trapezius muscle. There was no acute infection preceding the onset of the torticollis, but he was sick for a week, in 1919, with influenza. During this illness his temperature reached 101° F., but there was no diplopia or delirium. He smokes half of a package of cigarettes a day and takes no other stimulants. Frequently the patient's sleep is disturbed by screaming. However, he is not conscious of his outcries. His family life is normal and he has one child, age 13.

Physical Examination.—There were present irregular spasms of the left sternocleidomastoid, platysma and trapezius muscles, most pronounced while walking and less evident while lying down. His occiput was drawn to the right, pointing the chin upward to the left. There was hypertrophy of the right sternocleidomastoid and trapezius muscle. All laboratory tests were negative. **Diagnosis:** Mild spasmodic torticollis, on an organic basis, which improved markedly with baking, faradism and deep massage.

The patient was readmitted October 31, 1935, when it was found that the spasms of the right neck muscles had become more pronounced and, at times, very persistent. Examination showed the occiput rotated to the right and backward which pointed the chin to the left. The right shoulder was arched during the spasms. There was pronounced hypertrophy of the right sternocleidomastoid and scapular division of the trapezius muscle. With a little emotional activity, these muscles jerked violently, turning the head through 90° from right to left. During this period of hospitalization, a very thorough attack from a mental standpoint was made upon his torticollis, but with no more than a very temporary effect upon the spasmodic movements.

Operation.—January 8, 1936: A section of the right spinal accessory nerve was accomplished. The proximal end consisting of one-half of the total nerve was sutured into the entire distal end of the nerve (Fig. 2B). Postoperatively, there was a paralysis of the right sternocleidomastoid and trapezius muscles. The position of his head was more erect and he felt better. He returned, February 20, 1936, to the surgical follow-up clinic and stated he was definitely improving. On attempting to walk, there was a tendency for the former distorted position of the head and neck to recur. It was thought advisable to operate, in addition, on the first, second, and third cervical roots, in order to accomplish a better result. In June, 1936, the patient returned greatly improved, was able to hold his head erect, and power had returned in the right sternocleidomastoid and trapezius muscles. There was a little increased tone in the sternocleidomastoid muscle but the irregular jerky movements were not present. The involuntary movements in the right sternocleidomastoid and trapezius muscles when they did occur, induced by walking, were so weak that they did not affect the position of his head.

CONCLUSIONS

A conservative method of treating spasmodic torticollis has been shown to give satisfactory results in two cases. The method is similar to that used by

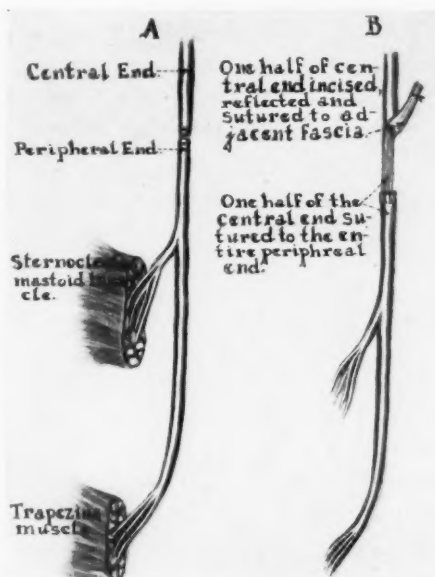


FIG. 2.—Drawing showing the technic of the surgical procedure employed in Cases 1 and 2.

Dogliotti in treating the facial nerve for facial spasms of an organic nature: namely, by a plastic reduction of motor fibers. The operation is less hazardous than cervical root and intradural, spinal accessory nerve section. If, in any case, a satisfactory result is not obtained, one may always resort to the latter procedure which stops spasmodic movements, but deprives the patient of considerable motor power in the neck and shoulders.

REFERENCES

- ¹ Dogliotti, A. M.: Guérison du spasme essentiel du nerf facial par réduction plastique des fibres motrices. Extrait des Bulletins et Memoires de la Société Nationale de Chirurgie. Seance du 11 Juillet, 1934, Tome LX, No. 25.
- ² Gray's Anatomy. Spitzka New American Edition, page 1009.

COMPLETE SYMPATHETIC DENERVATION OF THE UPPER EXTREMITY

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SYMPATHETIC denervation of the extremities has become a recognized therapeutic measure in the surgical treatment of peripheral vascular disease. The surgical procedures for sympathetic denervation of the upper extremity which have been employed most commonly during recent years involve extirpation of a portion of the sympathetic trunk including the inferior cervical ganglion and the first and second thoracic segments. These procedures are based on current knowledge regarding the sources of the sympathetic fibers which supply the upper extremity. These fibers leave the sympathetic trunk mainly through gray communicating rami which arise from the inferior and middle cervical sympathetic ganglia and join the nerves which make up the brachial plexus. In a large percentage of cases, sympathetic fibers which arise below the inferior cervical ganglion also join the brachial plexus, mainly via an intrathoracic ramus of the second thoracic nerve which joins the first (Kuntz,¹ 1927). All the nerves extending from the brachial plexus into the upper extremity include sympathetic fibers. The preganglionic neurons involved in the sympathetic innervation of the upper extremity are located in the upper thoracic region of the spinal cord, beginning with the first thoracic segment and extending downward at least as far as the third or fourth.

The importance of complete sympathetic denervation of the upper extremity in the surgical treatment of diseases in which marked peripheral vasoconstriction is a major factor has been emphasized repeatedly. Unsatisfactory clinical results due to incomplete sympathetic denervation of the extremity have also been reported in several instances.

Extirpation of the portion of the sympathetic trunk including the inferior cervical ganglion and the first and second thoracic segments, commonly referred to as cervicothoracic sympathectomy, effects complete functional elimination of all sympathetic fibers which supply the upper extremity except possibly a few, in certain cases, which enter the vertebral canal below the second thoracic segment, ascend in it and join the anterior roots of nerves which contribute to the brachial plexus. This has not been demonstrated anatomically in man, but has been demonstrated in cats by the use of experi-

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mental anatomic methods (Kuntz,¹ 1936). Observations reported following cervicothoracic sympathectomy in certain clinical cases also suggest that in man sympathetic fibers may enter the upper extremity from sources other than the cervical and first and second thoracic segments of the sympathetic trunk (Levy-Simpson, *et al.*;² Telford,⁵ 1934).

Cervicothoracic sympathectomy not only effects functional elimination of the sympathetic innervation of the upper extremity, but also of the corresponding side of the head and neck, due to interruption of the preganglionic fibers to the middle and superior cervical ganglia, thus producing an unwanted Horner's syndrome and abolishing perspiration in the area affected. It also results in degeneration of the majority of the sympathetic fibers in the upper extremity, due to removal of the ganglion cells from which they arise. Following degeneration of the vasomotor fibers, the vascular musculature becomes sensitized to adrenin; consequently, its tonus is markedly increased in response to adrenin in the circulating blood (Smithwick, Freeman and White⁴). The clinical results of sympathetic denervation, in many cases in which the operative treatment has been applied to both the upper and lower extremities, have been less satisfactory in the upper extremities than in the lower. This probably can be explained most satisfactorily on the assumption that the vascular musculature in the upper extremity became hypersensitive to adrenin in the circulating blood following degeneration of the vasomotor fibers. Sympathetic denervation of the lower extremity by the surgical procedure usually employed does not involve extirpation of the ganglion cells from which the vasomotor fibers to the extremity arise; consequently, the vascular musculature in the lower extremity does not become sensitized to adrenin.

In order to avoid the unwanted effects of extirpation of the inferior cervical and upper thoracic sympathetic ganglia, particularly Horner's syndrome and sensitization of the vascular musculature to adrenin, but still secure functional sympathetic denervation of the upper extremity, Telford,⁵ in 1935, advised section of the white communicating rami of the second and third thoracic nerves and crushing and division of the sympathetic trunk below the third thoracic ganglion, leaving the white communicating ramus of the first thoracic nerve, the sympathetic trunk ganglia and the gray communicating rami which join the nerves making up the brachial plexus intact. Smithwick³ has described an operative procedure designed to effect functional sympathetic denervation of the upper extremity which differs somewhat from that outlined by Telford. In this operation, the roots of the second and third thoracic nerves are divided proximal to the communicating rami and a short segment of each nerve is resected. The sympathetic trunk also is divided below the level of the third thoracic nerve, but none of the sympathetic trunk ganglia are removed and the gray communicating rami joining the nerves which make up the brachial plexus remain intact. This operation interrupts none of the preganglionic components of the first thoracic nerve. Its early clinical results in 11 patients, according to Smithwick, indicate that

few if any preganglionic components of the first thoracic nerve are involved in the sympathetic innervation of the hand.

The assumption that preganglionic components of the first thoracic nerve play no significant part in the sympathetic innervation of the upper extremity is not in accord with current teaching. In view of this fact and the importance of complete functional sympathetic denervation of the upper extremity in the surgical treatment of peripheral vascular disease, it has seemed desirable to obtain additional data regarding the distribution of the preganglionic components of the upper thoracic nerves by means of animal experimentation.

Methods and Results.—Preparations for the anatomic study of the distribution of preganglionic fibers in the inferior cervical ganglion have been obtained from cats. Some of these animals had been subjected to unilateral section of the roots of the second and third thoracic nerves proximal to the communicating rami, resection of a short segment of each of these nerves and division of the sympathetic trunk below the level of the third thoracic nerve. The others had been subjected to unilateral section of the roots of the first thoracic nerve and resection of a short segment of this nerve, including the origin of its white communicating ramus. The sympathetic trunk remained intact. These operations were carried out under aseptic conditions and the animals were allowed to live long enough (14 to 21 days) to insure degeneration of all interrupted preganglionic fibers. The inferior cervical ganglia were then prepared for study by means of a modified Cajal silver technic.

Preparations of the inferior cervical ganglia taken from the animals which had been subjected to the first operative procedure outlined above show complete degeneration of all the preganglionic fibers entering the ganglion at its inferior pole. The major portion of the intercellular fiber complex in the portion of the ganglion supplied by these fibers also has undergone degeneration, and the portion of the sympathetic trunk above the inferior cervical ganglion shows many degenerated fibers, indicating that many preganglionic fibers which arise below the level of the first thoracic segment continue upward in the cervical portion of the sympathetic trunk. The portion of the inferior cervical ganglion adjacent to the area through which the white ramus of the first thoracic nerve enters it shows no evidence of fiber degeneration (Fig. 1). The intercellular fiber complex in this portion of the ganglion is entirely comparable to that of the inferior cervical ganglion on the unoperated side.

Preparations of the inferior cervical ganglia taken from the animals which had been subjected to the second operative procedure outlined above show complete degeneration of all the preganglionic fibers entering the ganglion through the white communicating ramus of the first thoracic nerve. The major portion of the intercellular fiber complex in the portion of the ganglion adjacent to this ramus (Fig. 2) and a large percentage of the fibers in the portion of the sympathetic trunk above the inferior cervical ganglion also have undergone degeneration. At the inferior pole and in the adjacent por-

tions of the ganglion the intercellular fiber complex is entirely comparable to that in the corresponding portions of the ganglion on the unoperated side.

The above observations support the current view that the preganglionic fibers which effect synaptic connections with ganglion cells in the inferior cervical ganglion include components of the first thoracic as well as components of lower thoracic nerves. The portion of the ganglion in which the intercellular fiber complex undergoes degeneration following section of the white ramus of the first thoracic nerve, furthermore, includes large numbers of ganglion cells. Some preganglionic fibers of lower origin probably effect

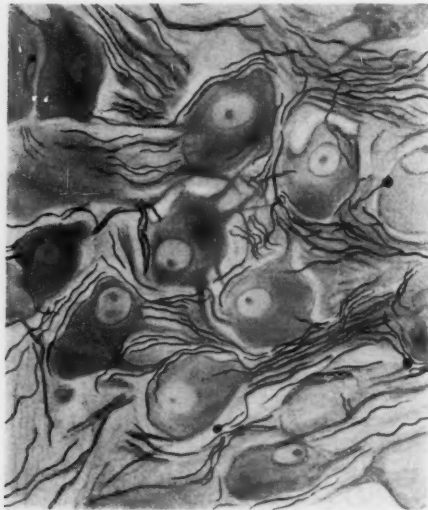


FIG. 1.—Drawing from a section of the inferior cervical ganglion of the cat adjacent to the area through which the white communicating ramus of the first thoracic nerve enters it, following degeneration of all preganglionic fibers arising below the first thoracic segment.

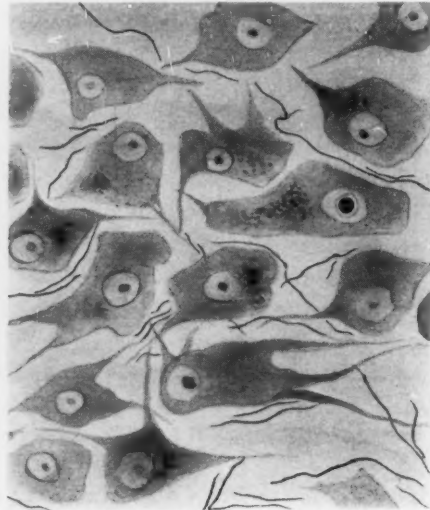


FIG. 2.—Drawing from a section of the inferior cervical ganglion of the cat adjacent to the area through which the white communicating ramus of the first thoracic nerve enters it, following degeneration of only the preganglionic fibers of the latter ramus.

synaptic connections in this portion of the ganglion, but the number of ganglion cells with which preganglionic components of the first thoracic nerve effect synaptic connections obviously is large. The distribution within the ganglion of the axons arising from these ganglion cells, furthermore, indicates that many of them enter gray rami which join the nerves which make up the brachial plexus.

Physiologic experiments in which the effects on the eye and the blood vessels and sweat glands of the upper extremity of direct stimulation of the preganglionic fibers in the first, second and third thoracic nerves were observed have been carried out on both cats and dogs. With the animal under anesthesia, the upper three or four thoracic nerves were exposed by incision lateral to the vertebral column and resection of the corresponding ribs. A galvanic current of threshold strength for the preganglionic fibers was used as stimulus. The electrode was applied at the cut surface of the distal portion of the divided ventral root. In case of the second and third thoracic nerves, it was some-

times applied at the cut surface of the distal portion of the ventral root and sometimes to the white communicating ramus.

Stimulation of the ventral root of either the first or the second thoracic nerve consistently resulted in dilatation of the pupil and retraction of the nictitating membrane. Stimulation of the ventral root of the third thoracic nerve resulted in retraction of the nictitating membrane but not in dilatation of the pupil. Section of the roots of either the first or the second thoracic nerve alone or its white communicating ramus did not produce Horner's syndrome, but section of the roots or white communicating rami of both these nerves consistently resulted in a complete Horner's syndrome.

Stimulation of the ventral root of either the first, the second or the third thoracic nerve resulted in activation of sweat glands in the paw pads and constriction of cutaneous vessels of the foot. The exact distribution of the sweat glands and cutaneous vessels affected by stimulation of each nerve separately has not been determined. It is significant, however, that sweating elicited by stimulation of the preganglionic fibers of the first thoracic nerve was apparent on all parts of the paw pads.

In certain experiments, using both cats and dogs, the distal portion of the ulnar artery was exposed and its reactions to stimulation of the ventral roots of the first and second thoracic nerves separately were observed under low magnification. Stimulation of either root resulted in marked constriction of the artery.

In one series of experiments carried out on dogs, kymographic records were made of the changes in blood pressure in the distal portion of the ulnar artery in response to stimulation of the ventral root of the first thoracic nerve. Simultaneous records of the general blood pressure also were made. These records indicate an initial increase followed by a decrease in pressure in the ulnar artery, without any change in the general blood pressure. The initial increase in pressure in the ulnar artery obviously is due to the contraction of its musculature in response to stimulation of preganglionic components of the first thoracic nerve; the decrease in pressure following the initial increase is probably due to the reduction in the volume of the blood flowing through the constricted artery.

Comment.—The anatomic data set forth above shows clearly that preganglionic components of the first and lower thoracic nerves effect synaptic connections in the inferior cervical sympathetic ganglion and that the fibers which extend upward in the cervical sympathetic trunk include preganglionic components of the first and lower thoracic nerves. This is in accord with current anatomic teaching. The responses of the iris to stimulation of the ventral roots of the first and second thoracic nerves indicate that both these nerves include preganglionic fibers involved in the sympathetic innervation of the eye. This also is in accord with current teaching. The absence of Horner's syndrome following section of the roots of either the first or the second thoracic nerve alone indicates that the normal tonus of the dilator pupillae muscle may be maintained through the preganglionic components of either of

these nerves. Both the anatomic and the physiologic findings indicate that preganglionic components of the first thoracic nerve play an important rôle in the sympathetic innervation of the upper extremity both with regard to the sweat glands and the vascular musculature.

Comparative anatomic and physiologic data, as far as such data are available, indicate a close correspondence in the distribution of the preganglionic components of the thoracic nerves in the carnivora and man. If the distribution of the preganglionic fibers of the first thoracic nerve in man corresponds to the distribution of these fibers in the cat and the dog, sympathetic denerva-

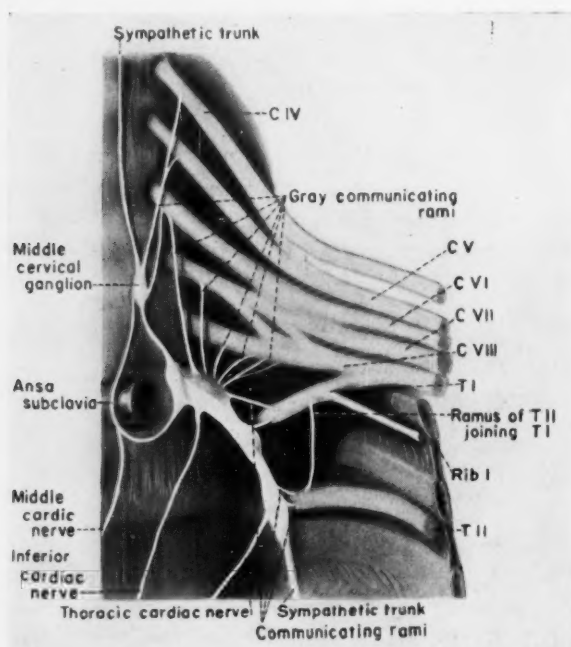


FIG. 3.—Drawing from a human dissection, illustrating the anatomic relationships of the sympathetic trunk and communicating rami to the nerves of the brachial plexus.

tion of the blood vessels of the upper extremity in man obviously cannot be accomplished by any operative procedure which leaves intact the first thoracic nerve with its communicating ramus and the inferior cervical ganglion with the gray communicating rami which connect it with the nerves which make up the brachial plexus (Fig. 3).

In view of the damaging effect of sensitization to adrenin of the vascular musculature following degeneration of the postganglionic vasomotor fibers in cases of vascular disease in the upper extremity, it must be regarded as advantageous to leave the sympathetic trunk ganglia *in situ* in order to avoid interruption of the gray communicating rami which join the nerves making up the brachial plexus. Interruption of the white communicating ramus of the first thoracic nerve, in addition to interruption of the white communicating ramus of the second thoracic nerve and division of the sympathetic trunk

below the level of the second thoracic ganglion, is essential to insure complete functional sympathetic denervation of the upper extremity. If the sympathetic trunk is divided between the second and third thoracic ganglia, section of the communicating ramus of the third thoracic nerve, according to our present knowledge, can have no effect in the sympathetic denervation of the upper extremity unless fibers arising in the third thoracic ganglion ascend in the vertebral canal and join nerves which contribute to the brachial plexus.

SUMMARY.—The preganglionic fibers which effect synaptic connections in the inferior cervical sympathetic ganglion include components of the first and lower thoracic nerves. Preganglionic components of the first and lower thoracic nerves also extend upward in the cervical portion of the sympathetic trunk. These findings are in agreement with current teaching.

The axons of inferior cervical ganglion cells with which preganglionic components of the first thoracic nerve effect synaptic connections are relatively widely distributed in the upper extremity, particularly its distal portions, both to the vascular musculature and the sweat glands. If the inferior cervical sympathetic ganglion and the gray communicating rami connecting it with the brachial plexus are left intact, complete functional sympathetic denervation of the upper extremity cannot be effected without interruption of the white communicating ramus of the first thoracic nerve.

REFERENCES

- ¹ Kuntz, A.: Distribution of the Sympathetic Rami to the Brachial Plexus: Its Relation to Sympathectomy Affecting the Upper Extremity. *Arch. Surg.*, **15**, 871-877, 1927.
- The Autonomic Nervous System, 2nd ed. Lea and Febiger Co., Philadelphia, 1934.
- The Autonomic Nervous System; Essential Anatomy, *J.A.M.A.*, **106**, 345-350, 1936.
- ² Levy-Simpson, S., Brown, G. E., and Adson, A. W.: Observations on the Etiologic Mechanism in Raynaud's Disease. *Proc. Staff Meet., Mayo Clin.*, **5**, 295-298, 1930.
- ³ Smithwick, R. H.: Modified Dorsal Sympathectomy for Vascular Spasm (Raynaud's Disease of the Upper Extremity. *ANNALS OF SURGERY*, **104**, 339-350, 1936.
- ⁴ Smithwick, R. H., Freeman, N. E., and White, J. C.: Effect of Epinephrine on the Sympathectomized Human Extremity. *Arch. Surg.*, **29**, 759-767, 1934.
- ⁵ Telford, E. D.: Sympathectomy: A Review of One Hundred Operations. *Lancet*, 444-446, 1934.
- The Technique of Sympathectomy. *Brit. Jour. Surg.*, **23**, 448-450, 1935.

THE PROPHYLACTIC AND ACTIVE USE OF ZINC PEROXIDE IN FOUL SMELLING MOUTH AND NECK INFECTIONS*

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THERE are certain infections of the mucous membrane of the mouth and throat in whose pathogenesis *anaerobic and micro-aerophilic organisms* play a prominent part. These organisms are frequently found in mouths which are not kept in good hygienic condition. They may also be found in mouths which are apparently normal, but are more often observed where there is dental caries, or root infection, or where there is persistent irritation of the gums from deposits upon the teeth. These organisms frequently take part in the inflammatory process in the gums as in cases of pyorrhea, or in the ulcerated infections of the tongue and cheek, commonly called stomatitis. Whether they are primary invaders of normal tissue like the hemolytic streptococcus or the diphtheria bacillus is not known, but they frequently invade the tissues when there has been a break in the primary defenses of the mucous membrane, caused either by a foreign body such as a splinter, fish bone, tooth or a fractured jaw, or following an operative procedure such as tonsillectomy or tooth extraction. When such an invasion takes place they may simply produce a diffuse inflammation of the submucous tissues or they may cause necrotic ulcers which destroy large portions of the mucous membrane, or they may course through the lymphatics to the cervical lymph nodes, or they may spread by direct extension through the tissues causing extensive necrosis either downward through the floor of the mouth and into the neck or upward into the face, not infrequently extending into the orbit or beneath the temporal muscle into the pericranial tissues.

If the infection manifests itself as a severe cellulitis of the submucous tissues, either of the mouth or of the throat, it gives the typical picture described by Plaut¹ and by Vincent,² commonly known as "Vincent's angina." If the germs invade the floor of the mouth and burrow down into the tissues of the neck or invade the lymph nodes of the neck, they may threaten or produce a closure of the glottis which is called "Ludwig's angina."³

Differential Diagnosis.—Mild forms of inflammation of the mucous membrane of the mouth occur in patients after prolonged vomiting or prolonged starvation. The digestive action of gastric juice may produce ulcers in the mouth or on the lips which do not persist long after the vomiting ceases. In starvation cases the stomatitis has been attributed to lack of vitamins, and this is confirmed by the favorable response following the administration of these substances in many cases. Smears and cultures from these lesions usually do not reveal the activity of *anaerobic or micro-aerophilic organisms*.

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The hemolytic streptococcus commonly produces a diffuse cellulitis of the tissues of the throat and not infrequently spreads to the neck. By the rapid development of edema frequently threatens or produces a closure of the glottis, but there is usually no necrosis of the mucous membrane or of the deep tissues of the neck, and the odor of the exudate is not foul. Infections in which the *anaerobic or micro-aerophilic organisms* are playing the dominant rôle, result in both necrosis of the mucous membrane and necrosis of the deeper tissues, and the exudate has a rather characteristic and very offensive putrid odor. Usually the hemolytic streptococcus infections produce a high fever and a profound intoxication, while the infections due to the *anaerobic and micro-aerophilic organisms* produce less fever and less intoxication, and a more distressing and extensive destruction of tissue. The hemolytic streptococcus infections are very apt to arise acutely and rapidly subside, while the *micro-aerophilic and anaerobic infections* are more apt to develop slowly, spread insidiously and resolve less rapidly.

Bacteriology.—Anaerobic as well as aerobic cultures in the hemolytic streptococcus infections reveal large numbers of those organisms. The ordinary aerobic cultures in the foul smelling infections usually yield the ordinary mouth organisms with the nonhemolytic streptococcus predominating. However, if a dark field illumination is used for examination of the exudate, fusiform bacilli, spirilla, or spirochaetae may be seen. Both *Treponema macrodentium* and *Treponema microdentium* are found. The spirochaetae are almost always present in the severest cases, but may be absent from the mildest forms. When anaerobic cultures are made, nonhemolytic streptococci are usually found on the blood agar plates which are either strictly anaerobic or micro-aerophilic. With the special media recommended by Smith⁴ and others, the fusiform bacilli, spirilla and spirochaetae may be obtained. The fusiform bacilli grow out in 48 hours in plain cooked meat medium to which 10 per cent ascitic fluid has been added. The spirochaetae grow out in eight to ten days in 33 per cent sheep or beef serum in distilled water to which a bit of sterile rabbit kidney has been added. *These organisms are not pathogenic when injected into animals in pure culture, but when they are combined they have a synergistic action which produces a more or less extensive lesion.*

The odor of the lesion arises from the development of gases by the bacterial action on the tissues. When these organisms are cultivated artificially it is found that the nonhemolytic anaerobic streptococcus is the only one which in pure culture will produce a foul odor. The spirochaeta *T. microdentium* produces an unpleasant odor but it is not foul. When the streptococci and the spirochaetae are combined, the odor is very foul and resembles that coming from the infected tissues.

Treatment.—When the *anaerobic and micro-aerophilic organisms* are present in the mouth unaccompanied by any inflammation, they may be minimized or eliminated by a number of oxidizing agents such as potassium chlorate, potassium permanganate, or sodium perborate, but they are more quickly and more effectively eliminated by the use of zinc peroxide. When, however, there

is an infection either mild or grave with an invasion of the submucous tissues, and superficial ulceration of the mucous membrane, zinc peroxide is much more effective in treatment than the other oxidizing substances. When the infection has spread to the deeper layers either directly or through the lymphatics, surgery is required and *should be radical*, extending well beyond the area of indurated tissue and opening the involved facial spaces. It is frequently necessary to remove masses of lymph nodes or the submaxillary salivary glands in order to effect the proper drainage. If the incisions have not been carried to the limit of the necrosis, it will continue to spread and cause a great deal more destruction. This has been illustrated over and over again when conservative operations have been attempted, in the dental clinic for example, and the cases have had to be subsequently taken into the hospital for more extensive surgery. When the tissues have been opened by adequate surgery, however, the infection can be brought under control by the careful application of zinc peroxide suspended in sterile distilled water, to every part of the infected surface. If this is done, the foul odor will almost immediately disappear, and smears and cultures of the exudate will show rapidly decreasing numbers of the spirochaetae, fusiform bacilli and the anaerobic streptococci.

The zinc peroxide must be an effective preparation as shown by preliminary tests⁸ indicating its ability to liberate oxygen when suspended in distilled water.* It should be sterilized in small quantities at 140° X? dry heat for four hours, and applied as follows: The dry powder is suspended in approximately an equal quantity of water so that it has the consistency of 40 per cent cream. It can be suspended evenly with an "Asepto" syringe and applied with the syringe to every part of the wound surface. If there are any sinuses, it should be delivered into them through a catheter, but if there are any parts of the infection which cannot be reached, it will have to be opened up so as to permit contact, which is essential. When the whole surface of the wound has been covered, fine meshed gauze soaked in zinc peroxide should be placed over the surface, and the whole wound sealed with several layers of Vaseline gauze so as to prevent evaporation. The dressing should be changed daily. When the gauze is removed, at the end of 24 hours, the old zinc peroxide and exudate should be washed off with saline from an irrigating can. The zinc peroxide suspension is then applied as before. This technique has been more fully described in previous papers.^{5, 6, 7, 8, 9}

The zinc peroxide should also be used at the same time, as a mouth wash, about one part powder to four parts water. One mouthful every three or four hours coats the mucous membrane very well. This should be thoroughly spread around the surface of the mouth. If there are any lesions on the tonsillar walls or pharynx, it should be applied with a cotton swab. Gargling or swishing the material around in the mouth will usually not result in contact with the tissues back of the anterior pillar of the fauces.

When the smears and cultures have become entirely negative for patho-

* The only dependable product available at present is the "medicinal grade" of zinc peroxide made by the DuPont Chemical Company, Niagara Falls, N. Y.

genic organisms, simple dressings will be satisfactory. Our experience with these cases during the past two years has demonstrated the superiority of this treatment over any previous treatment: First, in the rapid subsidence of acute general symptoms; second, in the rapid resolution of the local process; third, in the rapid disappearance of the foul odor which is so offensive to the patient and to other patients in the neighborhood; and fourth, in the rapid healing of the wound.

We believe that zinc peroxide should be used as a prophylactic mouth wash in all cases preliminary to tonsillectomy or dental extraction. It is logical to believe that these serious infections would be greatly diminished if this were employed extensively. Preliminary studies of the flora of the mouth should demonstrate the presence of the offending organisms, and if they are present, treatment should be instituted a day or two before the operative procedure is carried out, until the organisms have largely or, if there is time, until they have completely disappeared.

ILLUSTRATIVE CASE REPORTS

Case 1.—No. 502485: J. S., female, married, age 20, was admitted to the hospital with symptoms and signs simulating acute appendicitis. At the operation, a relatively normal appendix was removed. The symptoms continued and subsequent studies seemed to indicate that they were of rheumatic origin. She was transferred to the medical service and during the course of her treatment it was thought advisable to remove several bad teeth; two in the left upper jaw were removed without incident and five days later three in the left lower jaw were extracted.

Next day the jaw pained severely and swelling appeared in the cheek and neck. The temperature rose on the second day to 101°F. and the white blood count to 14,500, with 87 per cent of polymorphonuclears. The swelling spread over to the right side of the neck and into the floor of the mouth very rapidly during the next 24 hours, and difficulty in swallowing and breathing began to be experienced. Under chloroform anesthesia, Dr. Rudolph Schullinger made a curved incision over the submental and submaxillary triangles. The submaxillary salivary glands were removed and the tissues beneath the floor of the mouth were exposed, from which pus and seropurulent fluid without much odor drained. Dakin's fluid was instilled through drainage tubes for two days with some improvement, but then the exudate took on the typical foul odor of anaerobic infections.

On the fifth day zinc peroxide applications were started. The foul odor promptly disappeared and the wound showed marked improvement. Thereafter healing progressed rapidly and the patient left the hospital on the eighteenth day.

No dark field examination was made of the pus obtained at the time of the operation, nor in fact until the day after the zinc peroxide treatment was begun. Then fusiform bacilli were found in the pus but they did not grow out in the anaerobic culture which yielded hemolytic streptococci, green streptococci and *Staphylococcus albus*. Five days later only the green streptococci remained, and two days later the cultures yielded no growth.

Case 2.—No. 509567: R. S., female, age 20, had had the left lower third molar removed without incident three weeks previous to admission. Two days before, the right lower third molar had been removed. It had an overhanging gum. Next day the submaxillary and sublingual tissues began to swell. On the day of admission she began to have difficulty in swallowing. Her temperature rose to 102°F., W.B.C. to 25,700, and her pulse was 92. The tissues under the mandible were hard and tender. Cold applications were made for 24 hours, but her temperature remained above 103° F. all day and in the evening rose to 104° F., W.B.C. to 33,000, and pulse to 89.

Operation.—The submental triangle was opened by the oral surgeon. The tissues over the right submaxillary gland were cut. Necrotic foul smelling material was found in the submental region, and the wound was dressed with Dakin's solution. The temperature fell to 101° F. after operation but mounted again to 103° F. next day, later falling to 101° F. There was slight general improvement but the swelling under the tongue increased, swallowing became more difficult, and the foul odor of the discharge was most distressing. It was obvious that a deeper and wider incision would be necessary, and she was referred to me for operation which was done, under chloroform anesthesia. The submaxillary triangles were opened and foul pus evacuated. Part of the right submaxillary gland and the necrotic submental nodes were removed; the wound was flushed with zinc peroxide suspension and then packed with gauze soaked in the same material, two rubber tubes being placed in each submaxillary triangle. Thereafter the temperature steadily fell, the edema subsided, the foul odor disappeared, the necrotic tissue separated and the swallowing rapidly improved. Eleven days after the last operation the granulations were active and the wound was healing rapidly.

A dark field examination of the pus revealed spirochaetae, fusiform bacilli, vibrios and cocci. The cultures yielded anaerobic hemolytic streptococci, fusiform bacilli and green streptococci.

On the sixth day only a few anaerobic streptococci and fusiform bacilli were found on the right side and none on the left. On the eleventh day the smears and cultures were negative for these organisms.

REFERENCES

- ¹ Plaut, H. C.: Le bacille fusiforme et le spirillum sputigenum dans les angines ulcereuses. *Compt. rend. Soc. de Biol.*, **58**, 805, 1905.
- ² Vincent, H.: Recherches bacteriologiques sur l'angine a bacilles fusiformes. *Ann. de l'Institut. Pasteur.*, **13**, 609, 1899.
- ³ Ludwig, W. F.: Ueber eine neue Art von Halsentzündungen. *Wurt. Korrespondenzbl.*, **6**, No. 4, 1837.
- ⁴ Smith, D. T.: *Oral Spirochetes and Related Organisms in Fusio-spirochetal Disease.* Baltimore, 1932, Williams & Wilkins Co.
- ⁵ Meleney, F. L.: Zinc peroxide in the treatment of Micro-aerophilic and anaerobic infections with special reference to a group of chronic ulcerative burrowing non-gangrenous lesions of the abdominal wall. *ANNALS OF SURGERY*, **101**, 997, 1935.
- ⁶ Meleney, F. L.: Zinc peroxide in surgical infections. *S. Clin. North America*, **16**, 691, 1936.
- ⁷ Meleney, F. L., and Johnson, B. A.: The prophylactic and active treatment of surgical infections with zinc peroxide. *Surg., Gynec. & Obst.*, **64**, 387, 1937.
- ⁸ Meleney, F. L., and Johnson, B. A.: Further laboratory and clinical experiences in the treatment of chronic, undermining, burrowing ulcers with zinc peroxide. *Surgery*, **1**, 169, 1937.
- ⁹ Meleney, F. L.: Use of zinc peroxide in oral surgery. *International Jour. Ortho. & Oral Surg.*, **23**, 932, 1937.

DISCUSSION.—DR. I. S. RAVDIN (Philadelphia) expressed his appreciation of the opportunity to say a few words in regard to the use of zinc peroxide in the control of infections due to anaerobic and micro-aerophilic organisms. His experience with the use of this substance began shortly after Doctor Meleney obtained his first potent preparation. The results in the early cases were variable, and all must be deeply in Doctor Meleney's debt not only for demonstrating the efficacy of this method of therapy, but also for seeing to it that the manufacturers finally provided a uniformly potent material.

The invasiveness of these organisms once they have gained a foothold is well known to all who have had the opportunity of observing their activity.

In the region described by Doctor Meleney, they may not only involve the orbit and pericranial tissues but they may also cause extensive necrosis of the facial bones and the calvarium.

It has been Doctor Ravdin's impression that the micro-aerophilic streptococci are frequently not primary invaders of an intact mucous membrane but that they invade the submucous tissues once the primary defense of an intact mucosa has been destroyed. Doctor Meleney has pointed out certain of the important characteristics in the differential diagnosis of the hemolytic streptococcus infections of the mouth and neck and those due to the anaerobic and micro-aerophilic streptococci. This was probably not meant to imply that the two types of organisms are not at times found simultaneously in infections of the floor of the mouth. In such instances there is rapid invasion with considerable edema and necrosis. The systemic effect is often profound and the true nature of the combined infection is often not appreciated until the more rapidly invading hemolytic streptococcus is brought under control and there remains the more slowly progressing, necrotizing lesion which results from the micro-aerophilic organisms.

Doctor Meleney very rightly pointed out that zinc peroxide is not in itself a panacea. It does not take the place of sound surgery when an extensive infection exists in the hyomandibular and cervical tissues. The advantages of zinc peroxide over other substances which liberate oxygen lie in several directions: First, the oxygen is liberated more slowly; and second, the salt which is formed as the oxygen is liberated is not in itself injurious to the tissues. One does not observe, therefore, the tissue injury which may result from the use of perborate or potassium chlorate solutions.

It is only fair to state that the excellent results which have been obtained by many, which amply verify Doctor Meleney's observations, could not have been achieved had zinc peroxide not been used with the same care with which Doctor Meleney uses it. The treatment demands the utmost care—more than is usually given by a junior house officer.

DR. HENRY S. DUNNING (New York) called attention to the fact that a great many postextraction infections are seen at the Columbia Dental School, and are probably increasing. They are very severe and an effort has been made for a long time to impress on the dental profession the necessity of removing infected teeth with the least possible amount of traumatism and without in any way, if possible, damaging the membrane around an apical abscess. It is realized that these are full of dynamite, as also are infections around third molars. If the third molar stays in the gum a long time, a flap of gum forms over it, under that an ulcer forms, and in this a mixed infection may develop, as a rule with Vincent's spirilla predominating. Until recently treatment of these has been with Dakin's solution and perborate of soda for some time before the extraction period. Sometimes these flaps are so large that they are traumatized by biting against them. It is very serious to operate upon a case and take out these submerged third molars before the condition subsides and the gum is less swollen. However, the patient is suffering a great deal of the time. Almost immediately after the tooth is removed, the flap of gum drops in the wound and that is the end of it—unless infection develops.

In one of the patients described this evening, which Doctor Dunning treated with Doctor Meleney, a true Ludwig's angina developed very rapidly. Doctor Dunning had another case that in four days resisted the most radical surgery that could be instituted and ended fatally.

The postoperative treatment of the wounds in postextraction cases is of

vital importance. Some of the cases encountered in the Oral Surgery Clinic have been operated upon carefully and followed up a few days, but others have gone untreated, some have been packed, and some curetted. Doctor Dunning said he could not speak strongly enough against packing or anything that will prevent drainage or a blood clot forming in the alveolus of the bone. He had been advocating leaving them wide open, putting in nothing at all except, perhaps, a sponge between the teeth in cases of hemorrhage, and having the patient bite on it, then washing the wounds until they absolutely heal up. A certain number of these wounds will go on to infection whether they have had good treatment or not. If they do go on to a Ludwig's angina or to a large subperiosteal abscess, then incision and drainage should be instituted at once in a hospital as soon as the case is seen. These mouth infections have been treated with permanganate, perborate of soda, Dakin's solution, zinc peroxide, and other agents; and in the cases Doctor Dunning has seen, zinc peroxide has given the best results. It has been much more efficient in cleaning up these foul smelling wounds than anything else he had ever seen. In infected jaws with osteomyelitis it has done more than anything ever known, and particularly in the type of case shown at this time has it been very, very successful in helping to clear up the infection. Doctor Meloney should receive united thanks for all the work he has done in bringing the use of zinc peroxide to the attention of the profession.

GLOSSITIS RHOMBICA MEDIANA

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GLOSSITIS rhombica mediana is a benign disease of the tongue characterized by the presence of a mass or plaque, ovoid or rhomboid in shape, situated in the midline of the dorsum of the tongue, just anterior to the V formed by the vallate papillae. There are usually no subjective symptoms, and the condition is commonly discovered by the physician or dentist, or even by the patient himself, in the course of an incidental examination of the oral cavity.

The process appears to be incidental and of little or no clinical significance, except that the diagnosis may be confused with that of cancer of the tongue. Of the 11 cases presented in this report, ten were referred to the Memorial Hospital with the tentative diagnosis of cancer of the tongue. Our purpose is to describe the characteristic features of glossitis rhombica mediana, and to point out that it may be readily differentiated clinically from cancer.

The condition was first described, in 1914, by Brocq and Pautrier,¹ who reported 17 cases under the title "glossite losangique médiane de la face dorsale de la langue." Subsequently sporadic case reports appear in the literature, until 1922, when Arndt² recorded one case and mentioned that 40 others of similar nature had been observed in an 18 months' period at the Skin Clinic of the University of Berlin. In 1923, Fordyce and Cannon³ described two cases of a lesion of the dorsum of the tongue, previously unknown to them, which clinically and histologically seems typical of the condition now under discussion. In 1924, Lane⁴ reported one case, and by modifying and shortening the original title given to it by Brocq and Pautrier, gave to the disease the still rather cumbersome name "glossitis rhombica mediana," by which it is now commonly known in the American literature. Zimmerman⁵ reviewed the subject, in 1929, on the basis of 29 cases collected from the literature. Since 1929, Abshier⁶ and Loos and Hörbst⁷ have each recorded one case. In 1934, Gougerot and Dechaume⁸ reported a series of lingual plaques which they considered typical of the dorsal glossitis of Brocq and Pautrier, of which some were not rhomboid and others were not located in the midline. They concluded that these "placques depapillées" were atypical or attenuated forms of glossitis rhombica mediana. In the present report, we have excluded all such atypical forms as being confusing and irrelevant.

It appears probable that Spencer and Cade⁹ have not recognized clinically the lesion which is now generally designated as "glossitis rhombica mediana." They use the latter term to describe a condition in which the rhomboid area on the dorsum of the tongue becomes coated with a "heavy fur" because "this por-

tion of the tongue is least pressed against the palate or scrubbed against the teeth." Obviously, the phenomenon which they describe is a natural and common consequence of limitation in the normal range of tongue movement following any painful form of glossitis (cancer, sepsis, radiation reaction, *etc.*). The presence of a heavy fur in the rhomboid area is the exact opposite of the non-papillated, relatively smooth and pink appearance generally considered as being characteristic of glossitis rhombica mediana. Neither Butlin¹⁰ nor Blair¹¹ makes any mention of a tongue lesion which in any way resembles the condition now under discussion.

Incidence.—The condition is comparatively rare, or at least seldom recognized. Including our series of 11, there are reported in the literature a total of 42 cases. In our clinic, the incidence is less than 1 per cent of all patients referred for diagnosis and treatment of suspected cancer of the tongue.

TABLE I
AGE INCIDENCE AND SEX DISTRIBUTION OF ALL REPORTED CASES OF
GLOSSITIS RHOMBICA MEDIANA

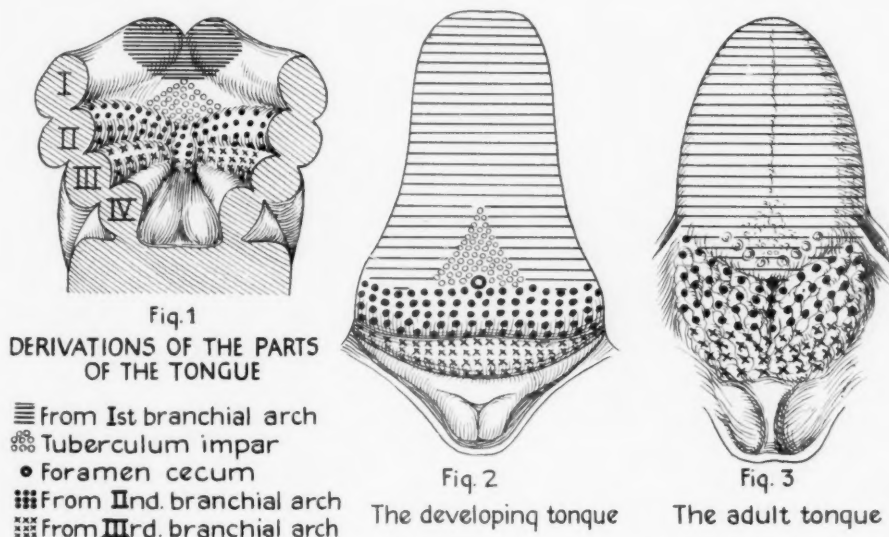
Age.....	15-20		21-30		31-40		41-50		51-60		—Total—		
Sex.....	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	Both
Zimmerman.....	0	3	3	0	8	4	5	0	6	0	22	7	29
(Collected series)													
Abshier.....									1		1		1
Loos and Hörbst.							1				1		1
Martin and Howe					4		4	2	1		9	2	11
All cases.....	0	3	3	0	12	4	9	3	8	0	32	10	42

Age and Sex.—Glossitis rhombica mediana appears to be a disease mainly affecting middle aged males. In our series, there were nine males (82 per cent) and two females (18 per cent). In Zimmerman's collected series of 29 cases, there were seven (24 per cent) females. Loos and Hörbst's single case occurred in a female. The average age in our series was 43—the youngest patient being 35 and the oldest 57, with ten of the 11 cases between the ages of 35 and 50. In Zimmerman's collected series, there were three females below the age of 20 and three males below the age of 30.

ETIOLOGY.—Predisposing Causes.—In our opinion, there is little or no evidence that this disease develops as the result of any of the common forms of chronic irritation. In all of our patients, there was a noteworthy absence of the usual sequelae of chronic irritation in the form of leukoplakia or diffuse glossitis. The incidence and degree of dental sepsis and the "coating" of the tongue in our series were about the same as those of the corresponding age and social group. The Wassermann reaction was found to be negative in all of our patients. This is contrary to the findings of Brocq and Pautrier, Dubreuilh,¹² May,¹³ and Fordyce and Cannon, but in all of these reports, it is significant that the process remained indifferent to vigorous and prolonged antiluetic therapy. All of our male patients had used tobacco and a similar

history is noted in the reports of others, but we feel that the absence of leukoplakia in all of our cases probably eliminates this source of chronic irritation as an etiologic factor. Since, in our opinion, there is so little evidence in support of an inflammatory or irritative origin for glossitis rhombica mediana, we have sought for an embryologic explanation, and have felt that it might possibly represent a persistence of the tuberculum impar.

Embryologic Development.—The tongue, embryologically, is a pharyngeal derivative—a “mucous membrane sac which becomes stuffed with skeletal



FIGS. 1, 2 and 3.—Drawings showing the embryologic development of the tongue (after Arey).

muscle.” The mucosa of the body or apical half arises from three primordia: the paired lateral swellings of the first or mandibular arches, and from the median somewhat triangular tuberculum impar which forms the pharyngeal floor between the first pair of branchial pouches. The mucosa of the root arises from a median ventral swelling, the copula, formed by the union in the midline of the second branchial arches. It receives some tissue from the third and fourth arches as well (Fig. 1). The mucosa of the apical half is papillae bearing; that of the root becomes infiltrated by lymphoid tissue. The body and root are demarcated from each other by the sulcus terminalis.

The tuberculum impar, in embryo, forms the posterior medial portion of the apical half and is in contact and continuity with the copula. Between these two is the point of origin of the thyroid diverticulum which, with fetal growth, becomes depressed into a pit and forms the foramen cecum (Fig. 2). As development proceeds, the paired lateral swellings of the first arches increase in size, at first fuse with the tuberculum impar, then grow more rapidly and outstrip it. Simultaneously, there is a “slipping forward” of the entire mucosa of the tongue. During this time, the tuberculum impar is fixed at the foramen cecum (and perhaps drawn caudad by the caudad proceeding thyroid) while it is tend-

ing to be overgrown anteriorly and laterally and overlapped posteriorly. Because of the eventual V shape of the sulcus terminalis, there seems to have been fixation of the central portion of the root as well (Fig. 3).

Consequently, the tuberculum impar does not normally appear in the human adult tongue, but if any of the factors tending to cause its disappearance were deficient or if it were reactivated by some metabolic or nutritional stimulus, a persistent tuberculum impar could result. It might persist in its most perfect form—a rhomboid area in the midline of the posterior dorsum of the tongue—but it could be anteriorly or laterally displaced, and of any shape. It could be split (Fig. 2) and appear in either two or three segments. It could appear in some form anywhere in the tongue except *posterior to the foramen cecum and the sulcus terminalis*. This persistence might be frank and on the surface or veiled by a superficial covering of the usual lingual mucosa.

Loos and Hörbst have come to the same conclusion as to the origin of the process, but classify it as belonging in the group of the vascular nevi, a classification which, in our opinion, is not well supported by histologic findings. It would seem to us that the tuberculum impar, whenever it has made an appearance, has simply demonstrated its kinship with the unapillated, lymphocyte infiltrated base of the tongue rather than with the papillae bearing apex. Under these conditions, glossitis rhombica mediana is more logically classified as an anomaly rather than as a disease.

SYMPTOMS AND CLINICAL FINDINGS.—In general, the process is of long duration and is usually attended by no subjective symptoms. Ten of our cases were referred to us with lesions discovered accidentally, and only one complained of vague discomfort. Of Brocq and Pautrier's 17 cases, one complained of slight pain on mastication, and one of a localized burning sensation. In May's case, there was slight interference with the movements of the tongue. The duration in most of our patients was short (three weeks to ten months), but we believe that if it were not for modern dental care and clinic facilities, many of these cases would have gone for years without remark. Brocq and Pautrier reported a case of seven years' duration, and Loos and Hörbst one of about 30 years' duration.

The typical lesion, as we have observed it, is a nonulcerated rhomboid or ovoid mass or plaque situated in the midline of the dorsum of the tongue just anterior to the apex of the V formed by the circumvallate papillae (Figs. 4 and 5). The mass or plaque usually extends forward for a distance of 2 to 3 cm., but is always sharply limited posteriorly by the sulcus terminalis. The surface of the lesion may be only slightly raised with borders which merge gradually into the normal level of the surrounding mucosa. In other instances, the lesion may be raised as much as 4 to 5 mm., with its edges arising rather abruptly from the tongue surface. In most instances, the involved area presents a definite difference in color and an absence of the normal papillary, furred character of the mucosa of this portion of the tongue. The change in the color and surface texture of the mucosa is usually rather abrupt and may

GLOSSITIS RHOMBICA MEDIANA

extend several millimeters beyond the raised portions of the lesion. The surface may be smooth and glistening or occasionally slightly fissured, and mammillated. There is no surface ulceration, but more or less induration is always present. Pain and tenderness are characteristically absent. The size and extent of the lesion, even though untreated and of long standing, is self limited to about $1\frac{1}{2} \times 3$ cm.

DIAGNOSIS.—Unless one is familiar with both diseases, glossitis rhombica mediana is quite apt to be confused with cancer of the tongue. Such characteristics as chronicity, absence of subjective symptoms, induration and apparent infiltration of the surface are common to both diseases. In our opinion, a clinical diagnosis of glossitis rhombica mediana should be made from the

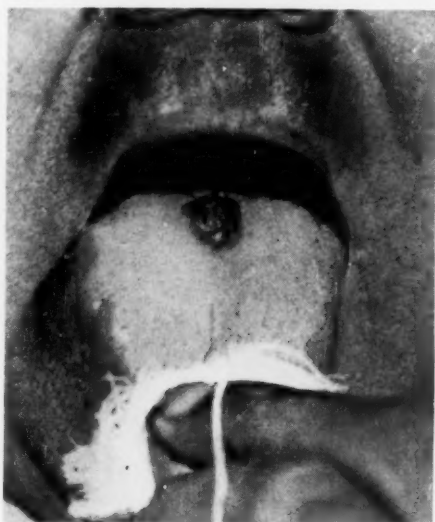


FIG. 4.—Photograph of Case 2, showing the typical midline situation of the growth in instances of glossitis rhombica mediana.

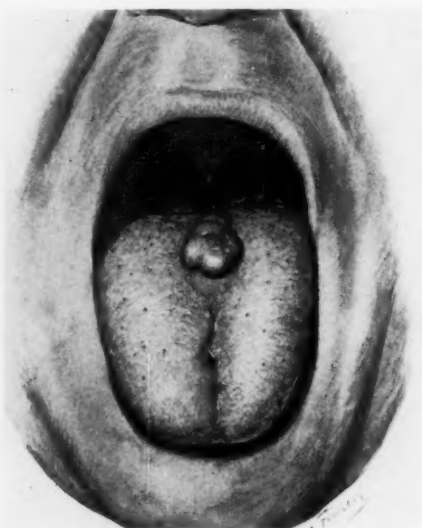


FIG. 5.—Drawing of the lesion in Case 11, showing more in detail the position and general gross characteristics of the growth.

unique position of the lesion—*directly in the midline of the tongue just anterior to the V line of the circumvallate papillae*. This area of the tongue is singularly free from *primary* cancer, although it may of course be invaded by extension from adjacent areas.

So far as we know, there is no instance of a malignant growth arising primarily in this area in about 2,000 cases of tongue cancer in the records of the Memorial Hospital. Cancer of the tongue characteristically arises in the lateral borders, the tip and at the base, posterior to the sulcus terminalis. Occasionally, growths arise on the dorsum of the anterior half, but never in the rhomboid area, to our knowledge. The same regional incidence also may be used to differentiate two other fairly common chronic lesions of the tongue: namely, gumma and tuberculous ulcers, which in our experience, are not found to arise in the rhomboid area. In our opinion, the diagnosis of glossitis rhom-

bica mediana may be made safely on the clinical features alone without biopsy. The unique position of this lesion in the midline of the rhomboid area of the tongue is its most significant diagnostic feature. Biopsy does no particular harm, but in our opinion, is unnecessary except for purposes of record.

MORBID ANATOMY AND HISTOLOGIC FINDINGS.—The lesion is quite sharply delimited in its borders and tends to involve only the mucous and submucous tissues whose thickness is increased to a variable degree. There is little or no tendency toward deep infiltration or invasion of the muscular body of the tongue, from which the mass is quite readily separated by surgical excision.

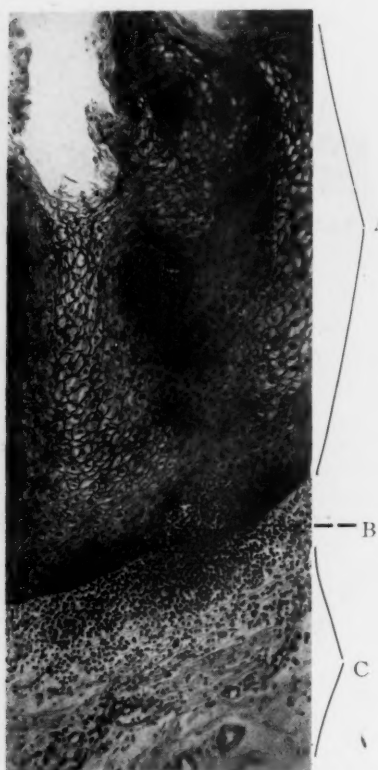


FIG. 6.—Case 5. Photomicrograph showing: (A) Hypertrophy, hornification and desquamation of epithelium. (B) Nodular mass of lymphocytes invading epithelium. (C) Subepithelial fibrosis and numerous plasma cells (high power).

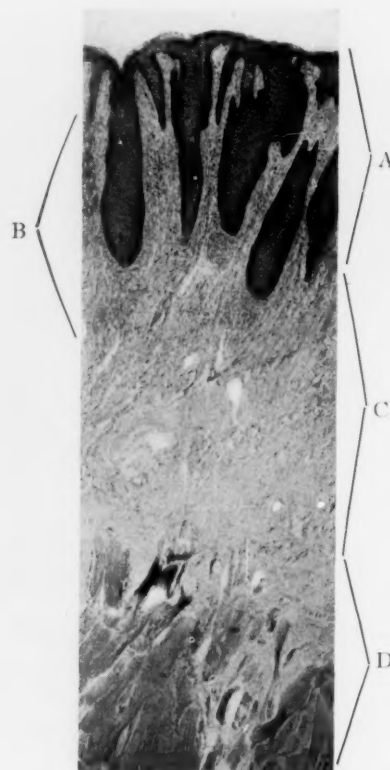


FIG. 7.—Photomicrograph showing: (A) Epithelial hypertrophy and downgrowth. (B) Lymphocytic infiltration of subepithelial and epithelial tissues. (C) Subepithelial fibrosis and edema. (D) Atrophy and degeneration of muscle fibers (low power).

The histologic findings are not uniform. There is usually a variable degree of hypertrophy of the epithelium with a tendency toward plexiform downgrowth of well differentiated cells, and occasionally, orderly pearl formation. The surface layers are hornified and desquamating, and while well developed fissuring is common, there may be only slight indenting of the surface cells.

A common finding is a diffuse lymphocytic infiltration of the subepithelial

tissues. Plasma cells may also appear and occasionally are a conspicuous feature (Case 5). Nodular masses of lymphocytes are commonly found just below the tips of the down-growing epithelial pegs, and in a few instances, such nodular masses have disrupted the basal layer of the epithelium and lie half in the subepithelial tissue and half in the epithelial tissue. Rarely, nodular masses appear entirely within the epithelial layer (Fig. 6).

There is almost always a considerable degree of fibrosis in the subepithelial tissues which may extend down to, and occasionally into, the muscle layer. When the latter condition occurs, the adjacent muscle fibers are atrophied or show marked hyaline degeneration and edema. The blood capillaries and the lymphatics are dilated and new capillaries may be seen in the process of formation. Occasional thrombi appear in the most superficial capillaries (Figs. 7 and 8).

We have found no evidence of malignant degeneration in any of the specimens examined in our laboratory. The epithelial growth is quite exuberant, but not disorderly, and the cells themselves are normal. The morphology and histology, as described in previous reports, are about the same as ours.

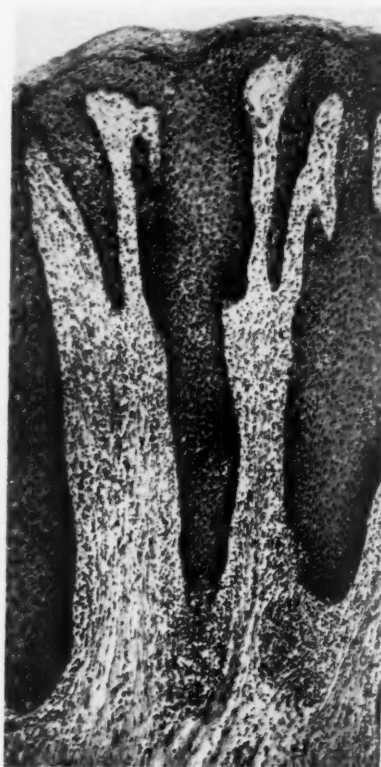


FIG. 8.—Case 5. Photomicrograph showing a higher power detail of Fig. 7, particularly the diffuse lymphocytic infiltration of subepithelial tissue. There is a tendency toward grouping of lymphocytes at the tips of the epithelial pegs and invasion of the epithelium by lymphocytes at these points.

CASE REPORTS

Case 1.—F. T., white, male, age 37, was admitted in June, 1932. Two months previously, he had noted on his tongue a small, painless "ulcer," which had gradually increased in size. He was a "heavy smoker."

Examination revealed in the midline of the dorsum of the tongue, anterior to the circumvallate papillae, a deep red area measuring $1\frac{1}{2} \times 1$ cm. In the center of this area was a nonulcerated, raised nodule less than 1 cm. in diameter. The lesion was slightly indurated. The remainder of the tongue was "coated." There was moderate dental sepsis, but no leukoplakia. The blood Wassermann reaction was negative.

Treatment and Clinical Course.—The lesion proved unresponsive to heavy doses of potassium iodide, and was excised by the endotherm knife in October, 1932. The wound healed by secondary intention. The patient was last seen in February, 1936, at which time there was no evidence of recurrence.

Case 2.—W. M., white, male, age 39, was admitted in January, 1933. Two and one-half years previously, he had been informed by his dentist of the presence of a lesion

on his tongue. It was symptomless and had not increased in size. He was a moderate pipe smoker.

Examination revealed in the midline of the dorsum of the tongue, just anterior to the circumvallate papillae, a raised, irregular, nonulcerated lesion measuring $1\frac{1}{2}$ cm. in its longest diameter (Fig. 4). There was moderate associated glossitis, but no leukoplakia. The blood Wassermann reaction was negative.

Treatment and Clinical Course.—The lesion was removed by surgical excision in February, 1933; healing by primary union. The patient was last seen in August, 1936, at which time there was no recurrence.

Case 3.—V. S., white, male, age 35, was first seen in December, 1934. Five months previously, during a tonsillectomy, a "tumor" was removed from the dorsum of the tongue. He was referred to the Memorial Hospital with a diagnosis of "epithelioma." The patient smoked about 20 cigarettes daily.

Examination revealed in the midline of the dorsum of the tongue, posteriorly, a ridge like, pinkish, nonulcerated lesion 3 cm. in its longest diameter. To the left of this was a small, superficial, whitish slightly indurated area with the appearance of a superficial abscess. The mucosa of the entire tongue was hypertrophied. There was moderate dental sepsis, but no leukoplakia. The blood Wassermann and Kahn tests were negative.

Treatment and Clinical Course.—No active treatment was given in our clinic, and he was last seen in May, 1935, at which time there was no apparent change in the lesion. He has failed his subsequent appointments.

Case 4.—O. M., white, male, age 57, was first seen in May, 1935. Two months previously, a small circular plaque appeared on the dorsum of the tongue. It caused no discomfort and had not increased in size. He stated that he had smoked about 30 cigarettes daily for some years.

Examination revealed, in the midline of the dorsum of the tongue, just anterior to the vallate papillae, a raised, pinkish, slightly indurated, rectangular patch. The surrounding mucosa presented a furred yellowish appearance. There was moderate dental sepsis, but no leukoplakia. The blood Wassermann and Kahn tests were negative.

Treatment and Clinical Course.—He was followed at intervals until August, 1935, without any apparent change in the lesion, but has failed his subsequent appointments.

Case 5.—J. R., white, male, age 42, was first seen in September, 1935. Five months previously, he had noted a reddish spot in the center of his tongue. It was symptomless, but during the preceding month had slowly increased in size. He admitted being a moderate smoker.

Examination revealed, in the midline of the posterior third of the dorsum of the tongue, a slightly raised, pinkish area, measuring 2 cm. in its longest diameter. Its borders were ill defined and irregular. The surrounding mucosa was pale yellow. Intra-oral hygiene was fair, and there was no leukoplakia. The Kahn test was negative.

Treatment and Clinical Course.—In September, 1935 a total of eight millicuries in four gold filtered radon seeds were implanted in the lesion. Regression was incomplete, and, in November, 1935, the lesion was surgically excised. He was last seen in September, 1936, at which time there was no evidence of the original disease.

Case 6.—I. S., white, male, age 49, was admitted in October, 1935. Three weeks previously, he had noticed a pinkish area on the dorsum of his tongue. There were no subjective symptoms. He had smoked about 40 cigarettes daily for several years.

Examination revealed, in the midline of the dorsum of the tongue, just anterior to the circumvallate papillae, an ovoid, pinkish, smooth area with slight thickening of the mucosa at the center. The surrounding mucosa was thickly coated. The Wassermann reaction was negative.

Treatment and Clinical Course.—He was advised to stop smoking and as to the proper procedures to improve oral hygiene. He was last seen in August, 1936, when there was some improvement in the general oral hygiene, but there still remained one small area of residual glossitis.

Case 7.—B. K., white, male, age 43, was first seen in December, 1935. Two months previously, because of an "uncomfortable" feeling in his tongue, he consulted his own physician who referred him to Memorial Hospital for diagnosis and treatment. At no time had there been actual pain in the tongue. He smoked about 15 cigarettes daily.

Examination revealed, in the midline of the dorsum of the posterior third of the tongue, a reddened area, measuring $2 \times 1\frac{1}{2}$ cm., over which the epithelium was smooth and glistening. There was slight resistance at the center of this area, but true induration was not present. The blood Wassermann reaction was negative.

Treatment and Clinical Course.—He was not seen again until March, 1936, at which time marked regression was noted. No treatment of any kind had been given. In April, 1936, the tongue was fairly normal in appearance. He was last seen in October, 1936, with no recurrence.

Case 8.—C. L., white, female, age 46, was first seen in June, 1936. Ten months previously, she had noted a "spot" in the center of her tongue which looked like a collection of "white pimples." A little later she noted a burning sensation in this region and the area became red and roughened. Three months previously a biopsy had been made and reported as "squamous carcinoma." Some radium treatment had been given. There was no history of smoking.

Examination revealed, in the midline of the dorsum of the tongue just anterior to the circumvallate papillae, an oval, smooth, deep red, moderately indurated area $2\frac{1}{2} \times 2$ cm. in extent and slightly raised above the surface of the tongue. Over the surface of the lesion, the papillae were atrophied and there was an absence of the furring present over the remaining surface of the tongue. There was no marked dental sepsis. The histologic slides were obtained and reviewed and no evidence of cancer was found. The patient was referred back to her private physician without treatment.

Case 9.—A. S., white, male, age 40, was referred to Memorial Hospital in September, 1932, because of hoarseness. He was not aware of any abnormality of the tongue. He had smoked 15 to 20 cigarettes a day for many years. After examination of the larynx, a diagnosis of pachydermia of the vocal cords was made, and he was observed at intervals of about three months until September, 1936, when during the examination of his larynx, the examining physician noted an ovoid, sharply demarcated, pinkish area in the midline of the dorsum of the tongue just anterior to the circumvallate papillae. Its size was about $1\frac{1}{2} \times 3$ cm. The lesion was slightly raised and slightly indurated, and in its anterior aspects there were a few shallow transverse fissures. There was complete edentation and no glossitis.

Treatment and Clinical Course.—No treatment was given. The patient returned again in March, 1937, for examination of his larynx, at which time no change was noted in the appearance of the tongue lesion, and although the patient was aware of it, he stated that it produced no symptoms.

Case 10.—G. H., white, male, age 50, was seen in consultation in March, 1937. About ten months previously, he had first noted an area on the midline of the dorsum of the tongue which appeared to be of a different color from the rest of the tongue surface. He was a moderate smoker. There were no subjective symptoms. The patient stated that it was not raised above the surface at the beginning, but that later a slight elevation occurred. About nine months after the first appearance of the above mentioned lesion, he consulted a physician for an unrelated complaint and spoke to him about the tongue. This physician referred him to a surgeon who took a biopsy and treated him by the insertion of radon seeds. An acute localized radiation reaction occurred which regressed without causing any appreciable change in the appearance or character of the lesion.

Examination revealed, in the midline of the dorsum of the tongue in the rhomboid area, a pinkish red area, ovoid in shape, which lacked the furred appearance of the remainder of the tongue. The lesion was slightly raised and nodular and presented one

transverse fissure, but no ulceration. The histologic slide was obtained for review and the findings were typical of those observed in glossitis rhombica mediana.

Treatment and Clinical Course.—He was referred back to his physician without treatment.

Case 11.—L. S., white, female, age 44, was first seen in February, 1937. Three and one-half months previously, a "pimple" the size of a pea had appeared on the dorsum of the tongue and had grown slowly. At first she had experienced a sense of irritation in this region, but later all abnormal sensations had disappeared.

Examination revealed, in the midline of the dorsum of the tongue, just anterior to the line of the circumvallate papillae, a pale, pinkish, raised, lobulated, nonulcerated, slightly indurated lesion measuring $1\frac{1}{2} \times 1$ cm. and elevated about 4 Mm. above the surrounding mucosa (Fig. 5). The anterior third of the lesion was covered by normal mucosa, but in the posterior portion, the mucosa was smooth and glistening. The mucosa of the remainder of the tongue was normal in appearance. There was moderate dental sepsis. The blood Wassermann and Kahn tests were negative. No treatment was given and she was directed to return for interval observation.

TREATMENT.—No treatment is indicated except in patients with marked cancerphobia where mental relief is to be obtained only with disappearance of the tumor. In such instances, surgical excision is the method of choice. The lesion may be removed under local anesthesia by an elliptical incision just wide enough to completely include the margins and carried down to the musculature of the tongue. The necessary depth of excision can be accurately gauged by the palpable induration. The incision is closed by interrupted sutures to be removed on the fifth or sixth postoperative day. In our experience, and as one might expect from the histologic findings, the lesions have exhibited about the same response to radiation as the adjacent normal tissues. Three of our present series and several earlier cases (not included in this series because of insufficient clinical data) were irradiated without benefit. Electrodesiccation or the endotherm knife has been recommended by some authors, but these methods prolong convalescence unnecessarily, since they leave an open wound to heal. Surgical excision with immediate suture was used in a few of our cases to relieve marked cancerphobia and to obtain histologic material.

SUMMARY AND CONCLUSIONS

Glossitis rhombica mediana is not a malignant process. It may be differentiated from cancer of the tongue by its typical shape and location, and biopsy should not be necessary for diagnosis. The lesion is probably not of inflammatory or irritative origin. We believe that it may be of embryonal origin and that it may represent a belated appearance of that portion of the tongue derived from the tuberculum impar. No treatment is indicated, but, if because of cancerphobia the individual patient demands removal of the lesion, surgical excision is the method of choice.

REFERENCES

- ¹ Brocq, L., and Pautrier, L. M.: Glossite losangique médiane de la face dorsale de la langue. *Ann. de dermat. et syph.*, 5, 1, 1914.

- ² Arndt: (Case report.) *Zentralbl. f. Haut. u. Geschlechtskr.*, **3**, 341, 1922.
- ³ Fordyce, J. H., and Cannon, A. B.: A Hitherto Undescribed Condition of the Tongue. *Arch. de dermat. et syph.*, **8**, 749, 1923.
- ⁴ Lane, J. E.: Glossitis Rhombica Mediana. *Arch. de dermat. et syph.*, **9**, 547, 1924.
- ⁵ Zimmerman, L.: Etiology and Diagnosis of Brocq's Glossitis Rhombica Mediana. *Dermat. Ztschr.*, **54**, 168, 1929.
- ⁶ Abshier, A. B.: Glossitis Rhombica Mediana; Report of Case with Results of Treatment. *Arch. Dermat. and Syph.*, **30**, 409, 1934.
- ⁷ Loos, H. O., and Hörbst, L.: Nature of Glossitis Rhombica Mediana. *Arch. f. Ohren-, Nasen-, und Kehlkopfh.*, **138**, 122, 1934.
- ⁸ Gougerot, H., and Dechaume, M.: Critical Study of Smooth Syphilitic Plaques; Differentiation of Smooth Non-syphilitic Plaques; Atypical Forms of Lozenge-like Median Glossitis. *Ann. d. mal. ven.*, **28**, 801, 1934.
- ⁹ Spencer, W. G., and Cade, S.: Diseases of the Tongue. 3rd ed. Philadelphia, Blakiston's Son and Co., 1931.
- ¹⁰ Butlin, H. T.: Diseases of the Tongue. 2nd ed. London, Cassell and Co., 1900.
- ¹¹ Blair, V. P.: Surgery and Diseases of the Mouth and Jaws. 2nd ed. St. Louis, C. V. Mosby Co., 1916.
- ¹² Dubreuilh, W.: Glossite mediane de la face dorsale de la langue. *Ann. de dermat. et syph.*, **5**, 615, 1914-1915.
- ¹³ May, J.: Glossite losangica mediana. *An. facultad de med. (Montevideo)*, **7**, 219, 1922.
- ¹⁴ Arey, L. B.: Developmental Anatomy. 3rd ed. Philadelphia, Saunders & Co., 1934.

PLASTIC RECONSTRUCTION OF THE ESOPHAGUS*

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THIS operation has to be considered chiefly in patients with an impermeable stricture in whom the prospect of a permanent gastrostomy furnishes sufficient indication to warrant such a serious and difficult procedure. It may also be considered in cases of resection of the esophagus for any reason. At the present time such an indication is rarely presented, but when resection of the esophagus for carcinoma becomes a more common procedure, a wider field will be opened up.

The first attempts at reconstruction seem to have been made by E. Bircher, in 1894. He constructed a skin tube of the thoracic wall and united it with the esophagus stump above and the gastrostomy opening below. Both his cases died. The method was also used by Payr, Lexer, Küttner and Frangenheim, all of whom found difficulty resulting from the development of fistulae. These occurred at the junction of the skin tube and the gastrostomy and were due to ulcer formation caused by digestion of the skin tube by gastric juice. Wullstein proposed a plastic procedure which utilized a loop of jejunum below, with a skin tube connecting with the esophagus above.

One of the best known methods is that originally proposed by Roux, who completely mobilized a long loop of jejunum, and after reestablishing continuity of the gut, implanted the lower end into the anterior wall of the stomach, while its upper end was drawn through a subcutaneous channel on the anterior chest wall and united with the esophagus stump. Numerous authors used this procedure, but most of the cases resulted in failure.

Lexer combined the two methods by using a much shorter loop of jejunum for the lower esophagus, and forming the upper portion from a skin tube as suggested by Bircher. This method has found many supporters and a considerable series of successful cases has been reported. One such case was operated upon by Frangenheim, in 1921, and is reported by Haberland, formerly an assistant of Frangenheim, in the 1936 *Archiv für Klinische Chirurgie*, which cites the present condition of a patient 15 years after the esophagoplasty. He has grown to be a healthy young man, able to eat and swallow everything. There are included in the article numerous photographs and roentgenograms of the patient illustrating the peristaltic action of the new esophagus. Another similar case was reported by Alton Ochsner and Neal Owens before the American Surgical Association, in 1934 (ref. *ANNALS OF SURGERY*, 100, 1055, 1934).

Besides skin of the chest wall and small intestine, the transverse colon has

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also been used for plastic reconstruction of the esophagus. Similar methods of procedure were proposed independently by Kelling and Vulliet. Successful results were reported by V. Hacker and Schlagenhauser. A very interesting method is the construction of an esophagus tube from the wall of the stomach. It was originally proposed by M. Hirsch, and the names of Jianu and Halpern are connected with the further development of this procedure. Finally there is the total transplantation of the stomach under the skin of the anterior chest wall with insertion of the esophagus stump into the fundus of the stomach, as proposed by Kirschner. All these different methods are ingenious, and require a great deal of patience and perseverance on the part of the patient as well as the surgeon.

Case Report.—A. McK., male, age 50, had a resection of the thoracic portion accomplished three years ago for stenosis of the esophagus. A gastrostomy had been performed previously. The clinical diagnosis was carcinoma, but the biopsy was negative. The procedure employed was that described by Doctor Torek. The patient made a good recovery, and was able to manage quite well with the aid of a rubber esophagus which connected his esophagus stump with the gastrostomy (Fig. 1).

He was presented in that condition before the New York Surgical Society May 9, 1934, and the case report was in the *ANNALS OF SURGERY*, 101, 940, March, 1935. He was also cited in a discussion of Doctor Ochsner's case of esophagoplasty before the American Surgical Association (ref. *ANNALS OF SURGERY*, 100, 1055, 1934).

The patient became anxious to discard the tube in order to be able to work and to eat in restaurants. The various plastic procedures were therefore reviewed and it was decided to construct an esophagus from the skin of the chest wall. This method seemed to offer the simplest solution, especially if one considered that any intra-abdominal operation might be difficult on account of adhesions resulting from a

previous perforation of a duodenal ulcer and the presence of a gastrostomy. The procedure was to be divided into stages as follows: (1) Construction of a skin tube. (2) Closure of the upper end by joining the esophagus stump with the skin tube. (3) Closure of the lower end by joining the skin tube with the gastrostomy.

The first stage was carried out May 16, 1935. Two perpendicular incisions were made over the left anterior part of the chest, outlining a three-inch strip of skin extending from the esophageal opening to the gastrostomy. The skin edges were now care-

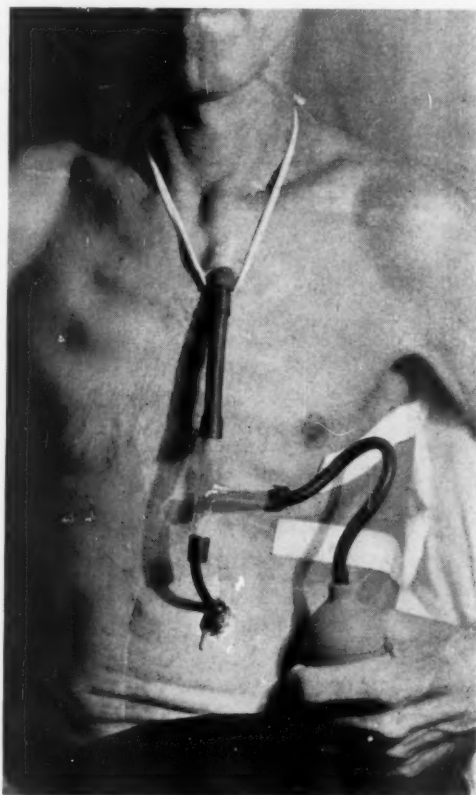


FIG. 1.—Photograph illustrating the rubber esophagus connecting the upper esophagus stump with the gastrostomy. The interposed rubber bulb is used to facilitate the passage of food downward.

fully undermined and by rolling them toward the midline they could be approximated with interrupted plain catgut sutures to establish a complete, skin lined tube ten inches long. The superficial fascia of the flap was now likewise approximated with interrupted plain catgut to reinforce the skin suture line. All sutures approximating the skin edges were so placed that they emerged at the skin margin without penetrating the skin itself. Above, construction of the skin tube was carried beyond the esophageal opening in order to have a funnel which would catch all saliva coming out of the opening, and

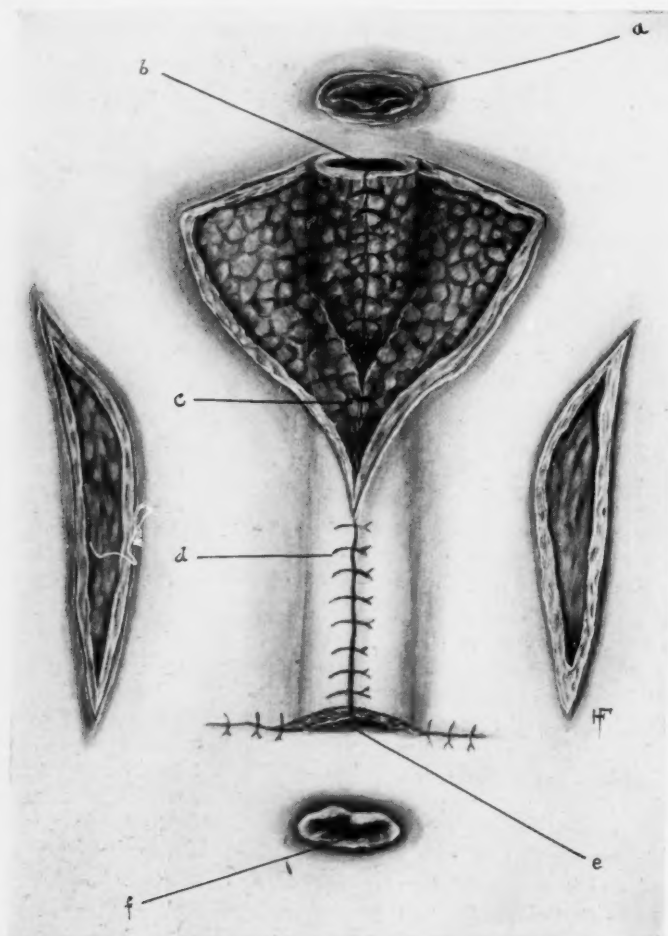


FIG. 2.—Drawing illustrating the formation of a ten inch subcutaneous skin tube to serve as a new esophagus. (a) Esophagus stump. (b) Upper end of new esophagus. (c) Suture of superficial fascia of skin tube. (d) Completed esophagus from skin of chest wall. (e) Lower end of new esophagus. (f) Gastrostomy opening.

to carry it downward. Below, however, the tube was constructed only to just above the gastrostomy in order to permit free access to it (Fig. 2).

The lateral skin margins were now undermined and thoroughly mobilized as far as the axilla on both sides. This permitted approximation over the newly formed skin tube in the upper two-thirds without undue tension. Below, however, it was necessary to make counter incisions to relax the tension. The releasing incisions were not covered with grafts, but allowed to granulate. They were used temporarily for drainage, in order to prevent stagnation of secretion under the large mobilized skin flaps. Other drains were

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placed at points of vantage and a large dry dressing applied. The patient withstood the operation well, and primary union, without any disturbance of healing, resulted in the entire ten inch tube as well as in its covering.

A month later, June 17, 1935, the upper end of the anastomosis was completed. The deep closure was quite simple, but there was so much tension on the edges of the undermined skin which was used to cover it, that subsequent separation was feared. However, only partial separation resulted, and the defect was later closed with a small pedunculated flap obtained from the adjacent skin.

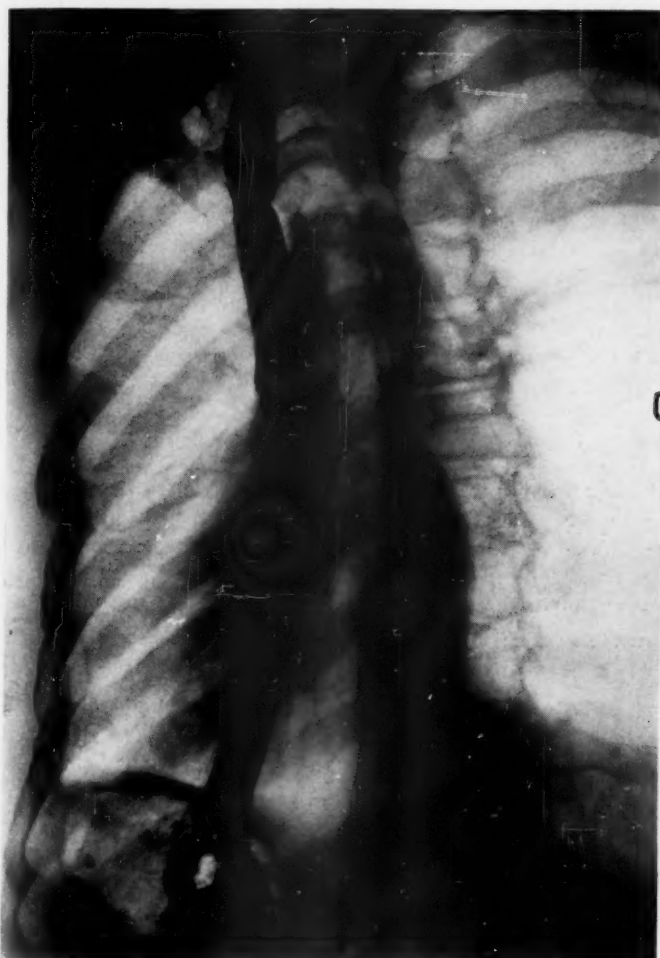


FIG. 3.—Roentgenogram demonstrating the function of new "skin tube" esophagus. Food passes down very rapidly by gravity plus muscular contraction of pharynx and esophagus stump.

There remains, then, the third step in the complete operation: namely, the anastomosis between the lower end of the skin tube and the gastrostomy. No doubt it could be carried out by the same procedure used at the upper end. However, the patient is reluctant to have this done, and after studying all the facts in the case, as well as the available literature, I agree with him. Ochsner states that of 32 patients who were operated upon by this method, 21 recovered, but that in 18 instances there was fistula formation at the

lower end. These fistulae, due to ulcer formation and digestion of the skin tube by regurgitated gastric juice, have been a source of great annoyance to nearly all patients. In spite of the fact that our patient has a Janeway gastrostomy, which insures against free leakage, he has had regurgitation with irritation and painful superficial ulceration. It is for this reason he prefers to leave conditions as they are.



FIG. 4.—Photograph showing the final result. Complete reconstruction of the esophagus except at its lower end where the skin tube connects with the gastrostomy.

reaching from the stomach to the lower end of the skin tube would be the method of choice.

The patient has constructed for himself a small tube, bent like a knee, one end of which fits snugly into the lower end of the skin tube, the other into the gastrostomy. There is no leakage at all. He is able to eat everything, and does not require an unusual quantity of fluid to wash down solid foods. He is able to eat in restaurants. At night he removes the tube, and then swallows water in order to wash out the esophagus to prevent fermentation. There has at no time been any irritation.

A recent roentgenologic study has shown excellent function (Fig. 3). It has not been determined to what degree gravity plays a rôle in the propulsion of food. The impression one gets is that the contraction of the pharyngeal muscles alone is sufficiently powerful to squirt food through the skin lined tube ten inches in length. As a matter of fact, food passes down so rapidly that it was not possible for Doctor Stewart to take a moving picture of the process.

The patient is well (Fig. 4). He has gained 50 pounds since the time of his esophageal obstruction. Any further operative intervention is hardly justified, but should one consider it, the transplantation of a short loop of jejunum

DISCUSSION.—DR. JOHN B. FLICK (Philadelphia) called attention to the fact that in most clinics carcinoma of the esophagus tends to resist treatment by various means despite the development of exact methods of diagnosis and the refinement of surgical technic. Theoretically, however, malignant lesions of the esophagus can be diagnosed early and should be curable by surgical removal of the lesion in selected cases. No other method of treatment at present offers any prospect of cure. One reason for the infrequent cure of cancer of the esophagus by the surgeon is the neglect of the patient, and also of the practitioner, to investigate early, vague symptoms of disturbance in swallowing. For a long time cancer of the esophagus is a purely local process.

DR. FRANZ TOREK (New York) expressed his pleasure in the fact that the demonstration of Doctor Eggers' results brought out the fact that there must be thorough exposure, an underlying principle without which success cannot be obtained. Carcinoma can be treated successfully only by radical removal. If radium were capable of treating the carcinoma without doing other damage, it might be a very good form of therapy. It is not sufficient, in surgery, to remove the carcinoma alone; a certain amount of supposedly healthy tissue must also be removed.

INFLAMMATORY TUMORS OF THE GASTRO-INTESTINAL TRACT*

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THE not uncommon confusion of the so-called inflammatory tumors of the gastro-intestinal tract with malignant and other diseases and the poor results which may follow failure to make this differential diagnosis warrants a review of the subject.

The terms, inflammatory tumor, infective granuloma,¹³ non-specific granuloma,¹¹ chronic cicatrizing enteritis,¹⁸ regional ileitis,¹⁷ and others, are all synonymous. They infer a type of chronic productive inflammatory reaction to infection with a tendency to the formation of a tumor or mass. Thus, they should be sharply differentiated from the specific granulomata of tuberculosis, lues, actinomycosis, *etc.*

A fairly thorough review of the literature yields a vast amount of varied information both factual and conjectural in character. Since recognition of the more widely accepted facts will probably lead to better diagnosis and treatment, it seems preferable to outline them rather than discuss many of the points still remaining controversial.

Ninety years ago Virchow,¹ discussing chronic peritonitis, described the formation of flat or villous-like thickenings on the peritoneum either single or multiple. He had observed their occurrence in the region of the appendix, hepatic, splenic, and sigmoid flexures of the colon. In some instances partial narrowing of the lumen with constriction was present. It was his impression that this peritonitis resulted from any inflammation of the intestinal wall by direct continuation or from other abdominal organs.

The problem lay practically dormant in the literature until Moynihan,² in 1906, read a paper entitled, "The Mimicry of Malignant Disease in the Large Intestine," in which, he reported six cases with a mistaken preoperative diagnosis of malignant disease. Four of these were diagnosed as consisting of chronic inflammatory tissue from various causes. He stated that: "The inflammatory tumors of the large intestine, excluding the tuberculous conditions, are, it would appear, far more frequent than we have supposed. The exact nature of the conditions present are not always the same. The inflammation may begin in and penetrate the mucosa, a false diverticulum may form and may perforate, extensive undermining ulceration may be combined with a form of polypoid growth or, finally, the inflammatory deposit may affect the peritoneal coat, chiefly or solely, leaving the mucosa

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supple and intact." While offering no etiologic classification, he emphasized the mimicry of malignant disease.

In 1908, A. W. Mayo-Robson³ detailed the record of 11 abdominal cases in which he had failed to differentiate inflammatory from malignant disease. His errors had occurred, once in the esophagus, four times in the stomach, once each in the small intestine, cecum, ascending colon, transverse colon and splenic flexure, and twice in the rectum. He related the satisfactory and frequently surprising results which he had obtained with short circuiting operations in some of these cases which had been diagnosed hopelessly incurable cancer. In view of this experience, he recommended exploration of all doubtful cases. Although he could offer no definite etiology, he clearly separated this group from the specific granulomata.

In 1909, Heinrich Braun⁴ reviewed the literature and, adding two cases, was the first to describe in detail the gross and microscopic pathologic pictures. He definitely set this apart from the specific granulomata. In 1911, Giffin⁵ reported an inflammatory mass around a diverticulum of the rectum and observed the possibility of fistula formation. Between 1907 and 1917, Proust and Lejars,⁶ Hamann,⁷ and Lee⁸ each added case reports. Lee's case illustrated the possibility of abscess formation in this disease. In 1912, McGrath,⁹ having found chronic extramucosal inflammation with mass formation in 27 cases of symptomatic diverticula of the large bowel, quoted Telling:¹⁰ "Of all the secondary results this proliferative inflammation is the most important, the most frequent and probably the most overlooked." He cautioned against the hasty labeling of colonic masses as malignant disease. He attributed the lack of luminal intestinal symptoms (bloody and purulent stools, *etc.*) to the relative freedom of the mucosa from involvement and stated that careful handling of such inflammatory masses may avert adhesions, fistulae, abscesses, peritonitis and death.

Thus, to this time, attention had been directed to the presence of these tumors frequently closely resembling malignant disease, both clinically and pathologically; to their inflammatory nature as distinct from tuberculosis, lues and actinomycosis; to the danger of intraperitoneal infection and to the production of strictures or fistulae in the course of the disease. The lesions had occurred in both the large and small intestines, stomach and esophagus, with the only ascribable causes mentioned being foreign bodies, ulcers and diverticula.

It was not until Moschowitz and Wilensky,¹¹ in 1923, reported four cases under the caption of "Non-specific Granulomata of the Intestines" that the surgical profession in this country showed real interest in the subject. Although recognizing the etiologic importance of foreign bodies and diverticula, they believed that the cause was usually unknown and felt that the erroneous diagnosis of hyperplastic tuberculosis concealed many instances of this disease. They noted that after sidetracking operations, the tumors frequently tended to disappear. Without doubt, their paper is responsible for the present increase in the recognition of the disease.

In 1928, Barron,¹² studying the occurrence of simple, nonspecific ulcers from esophagus to anus (ulcers other than those due to tuberculosis, lues, dysentery, typhoid fever, parasites and malignant disease) mentions them as another possible and difficultly recognized cause of this type of inflammation, especially in the colon. In 1931, Mock¹³ ventured the opinion that decreased blood supply and trauma may be etiologic factors in some cases. His advice to remove a section for biopsy in all apparently inoperable intestinal tumors should be accepted guardedly, since such procedure may excite serious sequelae. In 1932, Wilensky¹⁴ summarized his attitude toward the problem by stating: "Non-specific granuloma of the intestinal tract offers no characteristic clinical concept because the etiology, symptoms and signs are protean and indefinable." In 1932, Raiford¹⁵ classified the nonspecific granulomata of the gastro-intestinal tract as one of the lymphoblastomata, and emphasized the occasional difficulty of accurate pathologic diagnosis. In 1933, Erdmann and Burt¹⁶ suggested that the process may originate in an injury to the mucosa with subsequent ingress of infection of a low-grade type. In 1932, Crohn, Ginzburg and Oppenheimer¹⁷ introduced the term, "regional ileitis." They believed that the terminal ileum is involved selectively enough to constitute a new clinical entity. Their observation of the growth of a granuloma at the site of previous strangulation of intestine supports Mock's contention that the process may be initiated by an impaired blood supply. In 1933, Harris, Bell and Brunn¹⁸ suggested the name, "chronic cicatrizing enteritis," based upon their belief that the process occurs throughout the small intestinal tract. This review indicates the rather wide acceptance of many facts.

Pathologically, the inflammatory tumor may be described as a chronic, productive; inflammatory reaction to various etiologic factors and may often involve all the coats of the gut. Early, it resembles chronically infected granulation tissue with many new blood vessels infiltrated by lymphoid and polymorphonuclear cells. Giant cells of the foreign body type are not infrequently found. Fibroblastic elements soon appear in the reaction which may now progress in several ways. It may persist as a productive inflammation and, with progressively diminishing blood supply, may eventuate in adhesive peritonitis or fistula formation, or by suppuration in abscess formation or peritonitis. Fibroblastic predominance may result in a dense stenosing cicatrix. The small intestine, particularly the ileum, shows mucosal ulceration and cicatrization somewhat more often than the rest of the gastro-intestinal tract. It should be emphasized that any part of the gastro-intestinal tract may be affected even though in the 51 cases reviewed, 26, or 51 per cent, occurred in the ileocecal region with six in the cecum, 13 in the cecum and ileum together and seven in the ileum alone. Excepting the younger age incidence in the ileum most cases have been reported in the cancer age group (40 to 60).

Grossly, the lesion is most often confused with malignant disease in

the large bowel and stomach, and with either malignant disease or tuberculosis in the small bowel and cecum.

The known causes may be grouped as either intra- or extra-intestinal. From within the gastro-intestinal tract diverticula, foreign bodies, non-specific ulcers, colitis and polypi represent the major causes. From without the gastro-intestinal tract foreign bodies, progression from other foci, and embarrassed blood supply are the important known factors. However, in addition, a large number of cases remain without any indication of the actual origin. The importance of these factors varies with the portion of the tract affected. In most of the cases involving the stomach, an ulcer has accounted for the reaction. Cases involving either or both the ileum and cecum have usually shown no more definite cause than the occasional presence of a foreign body or embarrassed blood supply. Especially in the ileum does the question of etiology remain uncertain. However, it may be suggested that the marked amount of lymphoid tissue in this area may be contributory to ulceration, thus possibly initiating the disease here. The large intestine exhibits diverticula and foreign bodies as primary factors.

The multiplicity and diversity of symptoms and signs preclude any great degree of accuracy in preoperative diagnosis. Some points, however, deserve emphasis as possible aids. Long standing indefinite symptoms such as a low grade of fever, anorexia, nausea and abdominal pain may suggest subacute or chronic disease of the gastro-intestinal tract.

The pathologic stage of the disease gives rise to wide variation in the clinical picture. The stage of infection may be ushered in as an enteritis or a colitis, adhesive peritonitis, diverticulitis, intra-abdominal abscess, visceral perforation or peritonitis. Suffice it to state that usually the process remains of indolent nature and only rarely, as in sigmoid diverticulitis, progresses to an acute fulminating peritonitis. The stage of intestinal obstruction is usually incomplete and may occur either before or after fibrotic stenosis of the bowel.

Enumeration of the symptoms and signs of the above would entail a description of almost all intra-abdominal diagnoses. Local tenderness, leukocytosis and a palpable mass may be present. Further considerations in diagnosis must take into account the location of the disease. The high percentage of error in preoperative diagnosis makes it essential to appraise, at the same time, the possibility of diagnosis at operation.

The complaints of a young individual may have suggested duodenal ulcer which roentgenologic evidence of pyloric defect or obstruction may have corroborated. Anemia may be present but the true cachexia of cancer is usually absent. Palpation of a mass in the upper abdomen may readily throw the weight of evidence to malignant disease. Inflammatory tumor must be thought of if the mass is larger, more tender and less hard than to be expected in the latter. If at operation a large tumor of the stomach and duodenum with many inflammatory adhesions and without metastases in the liver be encountered, the diagnosis may be reasonably suspected. Competent

observers have reported the presence of inflammatory tumors in the stomach and duodenum treated surgically as inoperable carcinoma. Subsequent disappearance of these tumors has attested to their inflammatory nature.

The occurrence of indefinite symptoms in the right lower quadrant may easily lead to error. It is here that the inflammatory tumor is most common. There may be a history of one or frequent attacks of enteritis, perhaps ulcerative in type with abdominal cramps, nausea and vomiting, slight fever and anemia. At this stage the diagnosis is usually not made. The mimicry of acute appendicitis is usually misleading but long duration of symptoms and anemia may arouse suspicion. Many cases operated upon and dismissed as chronic appendicitis reveal the correct diagnosis with the subsequent development of a mass or intractable fistulae. Direct trauma or strangulation of intestine in a hernia may antedate the onset of symptoms and the development of a mass. A mass palpated before or at operation calls for differentiation from ileocecal tuberculosis, lymphosarcoma, carcinoma and benign tumors.

The inflammatory tumor is usually not sharply limited in extent, may involve the ileum, cecum or both and is usually firm, with many adhesions. The presence of fistulae, either viscerovisceral or external, either initial or postoperative, almost labels the disease. Peri-intestinal abscesses are not uncommon. Dense fibrosis of the ileum may exist. The lesion may be multiple. The absence of active, pulmonary tuberculosis almost rules out ileocecal tuberculosis. Lymphosarcoma does not spread as widely, nor does it have the excess of inflammatory adhesions. Carcinoma may be partially ruled out by the smaller area involved, the very hard consistency of the tumor, the presence of metastases and the lack of early adhesions. Benign tumors should be recognized easily.

It may be suggested that the use of roentgenologic studies with barium, in the presence of small intestinal obstruction, submits the patient to the possible precipitation of acute intestinal obstruction and should be used only with the greatest caution. The factors mentioned above hold good for the entire small intestinal tract.

If the symptoms are of colonic nature one must look for presumptive aids in the history such as colitis, nonspecific ulcers, foreign bodies and especially diverticula. The inflammatory tumor does not develop the bloody stools, anemia and cachexia of right-sided colonic carcinoma nor the acute obstruction of left-sided colonic carcinoma. A tender mass may be palpable and associated with leukocytosis, indicating infection. Proctoscopy with biopsy and roentgenologic studies are useful. At operation the inflammatory tumor is larger, more widespread, less hard and lacks the metastases of malignant disease. Many inflammatory adhesions and small abscesses may be found.

Surgical recommendations should be governed by several factors: First, conservative surgery may, and frequently does, result in cure without the added risk of radical intervention. Second, the ever present chance for

error should allow for the occasional necessity of further surgery. Third, any surgical procedure meeting these standards and offering the opportunity of accurate diagnosis certainly has merit in itself.

We believe that these criteria definitely favor the side-tracking operations as the best solution of the problem, at least, until more is known of the etiology and diagnosis of the disease. The application in any part of the gastro-intestinal tract of this treatment seems to show sound basic advantages over the more radical procedures.

If all findings do not label a gastric mass as malignant, a gastro-enterostomy and biopsy of the regional nodes should be performed. This procedure may cure an inflammatory tumor and, if the biopsy is reported malignant, secondary resection may be completed with little loss to the patient. Furthermore, resection for an inflammatory mass carries not only the higher risk inherent in the operation itself but also the added danger of severe infection and fatal peritonitis.

In the ileocecal region conservative surgery offers a definite advantage. A simple side-tracking operation, with biopsy of regional lymph nodes, permits of more accurate diagnosis and probably will cure the inflammatory tumor. It will reduce the incidence of complications often following radical procedures. Lymphosarcoma, notoriously, is not amenable to surgical cure. Radiation therapy may be of some benefit. Hyperplastic tuberculosis may be resected after the diagnosis has been proven. Adenocarcinoma of the ileum may be secondarily resected even though these tumors metastasize and recur early.

Surgery of the large bowel carries the risk of severe and fatal peritonitis calling for care and judgment in selection of the operative procedure. Such procedure should be at least consistent with possible recovery. Any abscess should be incised and drained only, even though it is known that fistulae may persist. Simple removal of a foreign body may effect a cure. Biopsy in this region, except for removing a regional lymph node, is inadvisable. If the diagnosis of inflammatory tumor can be reasonably suspected, short circuiting types of operations certainly are desirable. If practicable, colocolostomy or enterocolostomy may be performed; if not, simple colostomy. If the tumor is readily delivered outside the abdominal cavity a Mikulicz type of procedure may be carried out. In the event of discovery that the process is of malignant nature, secondary operation may then be performed.

A total of 43 cases taken from the literature may be divided into three groups: seven of these involved the ileum alone. Thirteen involved the ileum and cecum and in some of these 13 there was additional involvement of other portions of the large or small bowel. Twenty-three involved only the large intestine exclusive of the cecum.

In the ileum alone, the seven case reports show seven resections with one death and two recurrences requiring secondary operation. The 13 case reports with ileum and cecum involved showed the following results. With nine resections, five cures occurred. The other four cases had two

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TABLE I

ANALYSIS OF CASES REVIEWED IN THE LITERATURE

Part Involved	Age and Sex	Treatment	Result	Comment	Reported By
Esophagus.....		Gastrostomy	Cure		Robson, 1908
Pylorus.....	31 M.	Gastro-enterostomy	Cure	Ulcer?	Robson, 1908
Pylorus.....	45 M.	Gastro-enterostomy	Cure	Ulcer?	Robson, 1908
Pylorus.....	48 M.	Gastro-enterostomy	Cure	Ulcer?	Robson, 1908
Pylorus.....	50 M.	Diet and rest	Cure	Ulcer?	Robson, 1908
Stomach.....	56 F.	Resection	Cure	Ulcer?	Mock, 1931
Stomach.....	52 F.	Resection	Cure	Ulcer?	Mock, 1931
Stomach, duodenum and pancreas.....	38 M.	Resection	Death	Ulcer?	Mock, 1931
Stomach.....	54 M.	Resection	Death	Ulcer?	Kolodny, 1935
Stomach.....	43 M.	Resection	Cure	Ulcer?	Kolodny, 1935
Ileum.....	20 M.	Resection	Two recurrences		Coffin, 1925
Ileum.....	25 M.	Resection	Death	Torn meso. (strang. hernia)	Mock, 1931
Small intestine.....	31 M.	Resection	Cure	Pneu. death (1 mo.)	Cave, 1931
Ileum.....	52 M.	Resection	Cure	Ulceration	Andrews, 1932
Ileum.....	30 F.	Resection	Cure		Hanford, 1933
Ileum.....	42 F.	Resection	Cure		Erdmann and Burt, 1933
Ileum.....	24 M.	Resection	Death		Harriss, Bell and Brunn, 1933
Ileum.....	28 F.	(a) Short-circuit (b) Resection	Cure	Two operations	Bockus and Lee, 1935
Cecum and ileum...	23 M.	Resection	Cure		Jones and Eisenberg, 1918
Cecum and ileum...	23 M.	Resection	Fistula, ab- scess	2nd resec.	Moschowitz and Wi- lensky, 1923
Cecum and ileum...	22 F.	Resection	Cure	Linen suture	Mock, 1931
Cecum and ileum...	18 M.	Resection	Cure		Erdmann and Burt, 1933
Cecum and ileum...	30 F.	Resection	Cure		Erdmann and Burt, 1933
Cecum, ileum and colon.....	60 F.	Resection	Death	2nd resec. (fis- tula)	Erdmann and Burt, 1933
Cecum and ileum...	37 F.	I. and D. abscess	Fistula	2nd resec.	Erdmann and Burt, 1933
Cecum and ileum...	30 F.	Resection	Cure		Molesworth, 1933
Cecum and ileum...	49 F.	Resection	Abscess	2nd I. and D.	Gordon, 1933
Cecum and ileum...	21 F.	Appendicectomy	Fistula		Janssen, 1933
Cecum and ileum...	64 M.	Short circuit and Roentgen-ray	Cure	2nd ex. oper.	Eggers, 1933
Cecum and ileum...	18 F.	Resection	Death		Harriss, Bell and Brunn, 1933
Cecum and ileum...	19 F.	I. and D. abscess, appendicectomy	Cure, fis- tula	2nd resec.	Harriss, Bell and Brunn, 1933
Cecum.....	50 M.	Resection	Cure		Robson, 1908
Cecum.....	F.	Exp. celiotomy	Cure		Jones and Eisenberg, 1918
Cecum.....	44 M.	Resection	Cure		Golob, 1932
Cecum and ascending colon.....	33 M.	Resection	Cure		Moschowitz and Wi- lensky, 1923
Cecum and ascending colon.....	44 F.	Resection	Cure		Moschowitz and Wi- lensky, 1923

TABLE I (Continued)

Part Involved	Age and Sex	Treatment	Result	Comment	Reported By
Cecum and ascending colon.....	57 M.	Short circuit and Roentgen-ray	Cure		Eggers, 1933
Ascending colon....	70	Short circuit	Cure		Robson, 1908
Trans. colon.....	50 M.	Short circuit	Cure		Robson, 1908
Trans. colon.....	50 F.	Resection	Cure?		Moynihan, 1908
Trans. colon.....	32 F.	Resection	2nd abscess	I. and D. cure	Lee, 1917
Trans. and splenic colon.....	62 F.	Short circuit	Cure		Moynihan, 1908
Splenic flexure, small intestine.....	50 F.	Double short circuit	Cure		Robson, 1908
Splenic flexure.....	44 M.	Resection	Fistula	2nd oper.	Moschowitz and Wilensky, 1923
Splenic flexure.....	20 M.	Exteriorized, excision	Cure		Mock, 1931
Sigmoid.....	58 F.	I. and D. abscess	Cure	Diverticulitis	Moynihan, 1908
Sigmoid.....	52 M.	Colectomy	Cure	Diverticulitis	Moynihan, 1908
Sigmoid.....	7 F.	Exp. oper.	Cure		Ashurst, 1908
Sigmoid (tubes and ovaries).....	49 F.	Exp. oper.	Cure		Mock, 1931
Colon and ileum....	M.	Resection	Recurrence	Two—2nd oper.	Coffin, 1925
Rectum.....	28 F.	Colostomy—Ab. perm. sec.	Cure		Moynihan, 1908
Rectum.....	50 M.	Colostomy	Cure	Closure	Robson, 1908
Rectum.....	50 M.	Colostomy	Cure	Closure	Robson, 1908
Rectum.....	56 F.	Resection	Cure	Diverticulitis	Giffin, 1911

deaths with three secondary fistulae and two secondary abscesses requiring four additional operations. One death followed a primary operation and one a secondary resection for fistula. One fistula persisted. The two cases with secondary abscesses, both of which were incised and drained, ended with two fistulae which were both reoperated upon a third time. Four conservative operations were performed in this group. One short circuit followed by radiotherapy yielded a cure as did one appendectomy. Incision and drainage of two primary abscesses resulted in two fistulae, which also were subsequently resected.

It is to be noted that three deaths, two recurrences, two secondary abscesses and three secondary fistulae requiring eight additional operative procedures do not incline one to consider that this type of surgery is all that is to be desired. It is certainly worthy of consideration, from a diagnostic standpoint, that all four cases having abscesses that were incised and drained, subsequently developed fistulae of an ileal type which tended to persist for a long time.

The 23 cases involving the large bowel showed these results. With 11 resections eight cures resulted, with two recurrences, two fistulae, and one abscess. In 12 cases conservative surgery yielded 12 cures. Seven of these 12 had a short circuiting procedure performed, and all recovered without any complications.

If the latter two groups of cases, totaling 36, are considered together these results may be observed: Twenty resections yielded 13 cures, with two deaths from primary operation, two recurrences requiring two secondary operations, resulting in one death, five persistent fistulae and three secondary abscesses all requiring reoperation. In 16 of these cases, conservative surgery of one type or another yielded 13 cures. Short circuiting performed eight times showed eight cures; exploratory celiotomy in four cases, three cures; exteriorization in one case, one cure; incision and drainage in three cases, one cure with two persistent fistulae. Omitting those cases that had only incision and drainage of an abscess from this group of 16, conservative surgery showed only one case without a favorable result. This may be contrasted, very definitely, with the frequent complications resulting from radical surgery.

The appended case reports are from the Second Surgical Division of Bellevue Hospital, New York.

CASE REPORTS

Case 1.—S. T., female, age 47, white, was admitted to the hospital April 17, 1926, with a seven weeks' history of irregularly, recurrent pain in the left lower quadrant with some nausea but no vomiting. Previously she had been quite constipated. There had been no weight loss.

She was subacutely ill without abnormal physical findings other than those localized to the abdomen. In the left lower quadrant there was a firm, round, orange-sized mass slightly tender and fairly mobile. Rectal and vaginal examinations were normal.

The temperature varied between normal and 101° F.; white blood cells, 17,200; polymorphonuclears, 85 per cent; red blood cells, 4,500,000; hemoglobin, 95 per cent; stools negative for blood; Wassermann negative; blood chemistry normal; cystoscopy normal; proctoscopy showed no visible pathology. Roentgenologic examination revealed incomplete obstruction of the midsigmoid.

She was operated upon 12 days after admission and a large, mobile mass was found in the left lower quadrant. This was composed of inflamed, thickened and adherent omentum and sigmoid colon. Several small abscesses were encountered during the exploration. A small splinter of wood about 2 cm. long was found in this mass when the omentum was separated from the sigmoid. However, no perforation of the sigmoid was seen. The splinter was removed and the abdomen closed with drainage.

The patient made an excellent convalescence, having been discharged on her twenty-fourth postoperative day, with the wound completely healed. For three years she has had no recurrence of symptoms and the mass has disappeared.

Case 2.—G. M., male, age 42, white, was admitted September 18, 1934, with a two day history of abdominal pain most marked in the left lower quadrant. He had had considerable vomiting and some dysuria. His past history elicited no prominent symptoms. He was acutely ill, dehydrated and had a distended and tender abdomen. Rectal examination showed marked tenderness on the left side. No mass was palpated. Temperature, 101.4° F.; urine, negative; white blood cells, 12,600; polymorphonuclears, 82 per cent.

He was operated upon shortly after admission and a diffuse peritonitis was found. In addition, the sigmoid was grossly inflamed and thickened and had many inflammatory adhesions about it. The abdomen was closed with drainage.

He had a stormy convalescence and was discharged on his thirtieth postoperative day. The wound healed completely without the formation of a fistula. Subsequent studies have

proven the presence of multiple diverticula of the sigmoid. The inflammation of one of these doubtless accounted for his illness.

Case 3.—M. R., female, age 37, was admitted August 1, 1933, with a three months' history of cramping, epigastric pain after meals. Alkalies eased the pain irregularly but vomiting gave constant and immediate relief. She remembered having had tarry stools several times. She had lost about 40 pounds in three to four months. Episodes of epigastric pain with vomiting had recurred for nine years and during this period repeated observation in various hospitals had resulted in no definite diagnosis. Three years before her admission, hematemesis and melena had been noted for the first time, and during the last three years both of these have recurred on several occasions.

She was a markedly emaciated young female, appearing chronically ill and complaining of fairly severe epigastric pain. Her head, neck, lungs, heart and extremities revealed no positive findings. The abdomen was soft, nontender, not distended and no masses were palpable. Rectal and vaginal examinations were negative.

Temperature rose to a maximum of 101° F. on several days. Pulse and respirations normal. Blood pressure, 98/72; urine, negative; white blood cells, 8,400; polymorphonuclears, 74 per cent; red blood cells, 4,500,000; hemoglobin, 80 per cent. Wassermann, negative; blood chemistry, normal. Repeated G.I. series showed only a very large atonic stomach and dilated duodenum.

After having left the hospital against advice on three occasions she finally consented to an exploratory celiotomy because of almost constant vomiting. She was operated upon August 15, 1933, with a preoperative diagnosis of high obstruction.

The operative findings consisted of a markedly dilated stomach and duodenum; a lemon sized mass in the jejunum, six inches below the angle of Treitz, causing almost complete obstruction; many soft small lymph nodes were found in the mesentery at this point. The mass was resected and a side-to-side anastomosis done and the abdomen closed without drainage.

Postoperatively a wound infection cleared fairly rapidly. She progressed well for about two weeks when the vomiting recurred. Conservative measures were of no avail. Roentgenologic studies again showed marked dilatation of the stomach and duodenum. It was felt that she might have been obstructed at the jejunojejunostomy stoma and she was reoperated upon September 27, 1933, six weeks after her first operation.

The abdomen contained a mass of adhesions between both the parietal and visceral peritoneum. The anastomosis appeared patent. The first portion of the jejunum was slightly hypertrophied and had a granular appearance. An anterior gastro-enterostomy was performed with an entero-anastomosis 20 inches below the angle of Treitz. The wound healed by primary union and she made good progress for another two weeks. At this time recurrence of vomiting seemed to indicate another obstruction from adhesions and she was reoperated upon November 4, 1933, six weeks after the second operation.

At operation the gastro-enterostomy and both entero-anastomoses were apparently functioning. The peritoneal cavity contained a mass of adhesions. The stomach was not dilated. The exploratory celiotomy, with lysis of the adhesions, was completed. Postoperatively she made some progress for about two weeks but died suddenly on the sixteenth postoperative day, approximately 30 hours after a recurrence of the vomiting.

Pathologic examination of the tissue removed from the jejunum at the first operation showed a stenosing lemon-sized tumor of the jejunum. It was interpreted as a chronic, productive inflammatory tissue. The mucosa was slightly ulcerated and the tumor showed a marked amount of fibrosis with infiltration by many lymphoid cells. Some giant cells were also present.

Autopsy revealed the presence of two other similar tumors, one in the duodenum and one low down in the jejunum. The origin of these tumors is unknown.

Case 4.—M. M., female, age 46, white, was admitted in December, 1934, with a one week's history of generalized abdominal cramps, with considerable nausea and vomiting and slight diarrhea. She believed this to be due to some type of food poisoning. With the

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onset of fever and some abdominal distention accompanied by constipation, she came to the hospital. She admitted having had some irregular lower abdominal pain with constipation for a few months before the present illness.

She was well developed and well nourished but chronically ill. Examination showed only abdominal distention and tenderness in both lower quadrants. A slight cystocele and rectocele were present, and the culdesac was slightly boggy but not tender.

Temperature on admission 103° F.; pulse and respirations, normal; urine, negative; blood pressure, 105/70; white blood cells, 12,000; polymorphonuclears, 78 per cent; Wassermann, negative; Widal, negative; red blood cells, 4,000,000; hemoglobin, 70 per cent. The stool was negative for blood. Culture and direct examination of the stool showed no abnormal findings. Proctoscopy negative. A barium enema, which was repeated, showed finger printing in the sigmoid and was interpreted as an infiltrative lesion. A diagnosis of possible foreign body perforation of the sigmoid with abscess formation was made, and operation carried out January 9, 1935.

Operation.—The pelvis and lower abdomen were a mass of adhesions in which were embedded the tubes and ovaries and the small and large intestines. This mass was the seat of an inflammatory reaction, the tissue being of porky consistency. The sigmoid was incorporated in this mass and its wall was tremendously thickened. The tubes were also markedly enlarged. There was a small amount of odorless pus, enclosed in the meshes of these adhesions.

Both tubes were removed by sharp dissection and an appendectomy with simple ligation of the stump effected. The abdomen was closed with drainage.

She died on the eighteenth postoperative day from an acute nephritis and sepsis. A postmortem examination revealed a small amount of purulent exudate in the lower abdomen, which showed a hemolytic streptococcus in pure culture as did the pus from the original abscess.

Friable adhesions were present throughout the abdomen, particularly low down. The wall of the large intestine at the rectosigmoid junction was thickened, firm and indurated without ulceration of the mucosa. The ileum and small intestine were intimately adherent to this mass. Microscopic examination of this tumor of the rectosigmoid region showed a chronic productive inflammatory reaction with an increase in the connective tissue, infiltration by lymphoid cells and some edema. The surgical specimen was reported as showing a chronic productive salpingitis.

Although the origin of this tumor of the rectosigmoid junction is not definitely established it seems probable that it may be due to progression from the pathologic process in the tubes.

Case 5.—T. G., female, age 61, white, was admitted June 10, 1935, with a four months' history of cramplike abdominal pain with nausea and irregular vomiting. She had noted intermittent constipation with distention. She had had no melena or hematemesis. She had gradually become weaker during the past two months, with a weight loss of approximately 30 pounds. She stated that on several occasions she had had some fever.

The patient was subacutely ill. Examination showed fairly marked tenderness over the lower abdomen, particularly on the left side. An irregular suprapubic mass was palpable but could not be definitely outlined. On bimanual examination the tumor seemed to be intimately connected with the posterior vaginal wall.

Her temperature ran irregularly between normal and 102° F.; red blood cells, 4,000,000; hemoglobin, 80 per cent; white blood cells, 11,000; polymorphonuclears, 85 per cent; urine, negative; blood pressure, 140/90; proctoscopic examination, negative; stools negative for blood.

At operation, June 14, 1935, an orange-sized mass was found in the sigmoid adherent to the ileum, which caused subacute obstruction of both the ileum and the large bowel. The adhesions encapsulated 50 cc. of thick, greenish pus.

In separating the adhesions the abscess was opened, and in attempting to free the sigmoid from the ileum, a small opening was accidentally made into the large bowel. This was closed after a small piece of tissue had been removed for biopsy. The wound was closed with drainage.

Postoperatively, she developed a fecal fistula which drained for a considerable length of time. The patient refused further surgery of any type and left the hospital, returning, however, to the O.P.D. for subsequent dressings. The fistula persisted for approximately one year when it finally closed spontaneously. It is now a year and one-half since operation and the patient is in excellent health.

The specimen removed from the tumor in the rectosigmoid region showed a dense granulation tissue in which there were numerous vessels. Considerable fibrous tissue of a dense character, with numerous fibroblasts, was present and was infiltrated by many round cells.

Case 6.—C. L., male, age 40, white, was admitted May 15, 1934, complaining of epigastric pain of ten years' duration. This occurred about an hour after each meal and was relieved by alkalis and emesis. There was no history of hematemesis or melena. During the past month he had had almost constant vomiting, having been able to retain only fluids. He had been operated upon previously for hemorrhoids and for a perforated appendix, both in 1932.

The patient was emaciated. No abdominal tenderness was present. No mass was palpated. Temperature, pulse and respirations normal. Urine, negative; white blood cells, 15,000; polymorphonuclears, 70 per cent; red blood cells, 5,000,000; hemoglobin, 100 per cent; gastro-intestinal roentgenograms showed complete retention of the gastric meal at 24 hours.

At operation, May 16, 1934, an orange-sized mass was found in the first portion of the duodenum and extended slightly over onto the gastric side. There were many adhesions to the surrounding structures. No metastases were felt.

A posterior gastro-enterostomy was performed; although it was felt that the tumor might be a carcinoma. A lymph node was taken for biopsy.

The patient made an uneventful postoperative recovery and left the hospital on the eighteenth postoperative day, against advice. Since that time he has gained 35 pounds in weight. Gastro-intestinal roentgenologic studies show good function of the gastro-enterostomy stoma, with a slight area of narrowing of the proximal jejunum about one-half inch distal to the site of anastomosis. The lymph node was reported to show subacute and chronic inflammatory changes without evidences of malignant disease. It is two and one-half years since operation and the patient is now enjoying excellent health.

Case 7.—F. A., male, age 54, white, was admitted February 1, 1932, with a 15 year history of epigastric pain with irregular vomiting. The pain had recurred frequently during this time. He had lost considerable weight. He was emaciated. The abdomen was soft and nontender. No mass was palpated. Rectal examination was negative.

Temperature, pulse and respirations normal. Urine, normal; red blood cells, 4,000,000; hemoglobin, 80 per cent; white blood cells, 9,500; polymorphonuclears, 70 per cent; stools negative for blood; gastric analysis showed both free and combined acid; gastro-intestinal roentgenologic examination demonstrated an ulcer of the first portion of the duodenum with considerable residue at 24 hours.

At operation a lemon sized tumor was found in the first portion of the duodenum mainly on the anterior and inferior duodenal wall. A crater was palpated in the center of the tumor. No metastases were present in the liver although there were many fairly large regional nodes. A posterior gastro-enterostomy was performed with biopsy of a regional node. The patient made an uneventful recovery except for a slight wound infection and was discharged from the hospital on the twenty-seventh postoperative day.

The biopsy of the regional node was reported to show chronic inflammation without evidence of malignant disease.

The patient has been followed for nearly five years and has had two herniae repaired

during that time. He has gained approximately 40 pounds in weight and has absolutely no gastric symptoms.

These latter two cases may be called duodenal ulcers with chronic productive inflammation around them causing tumor formation.

Case 8.—J. K., male, age 60, white, was admitted in May, 1921, with a 48 hour history of lower abdominal pain and vomiting. Examination showed an acutely ill patient with a temperature of 101° F., and leukocytosis of 23,000. No palpable abdominal mass. Preoperative diagnosis was acute diffuse peritonitis.

Operation revealed a mass within the pelvis involving the lower segment of the sigmoid and upper rectum. The mass did not have the consistency suggestive of carcinoma. A peach pit which had ulcerated through the inflamed colon was found and removed. No other pathologic specimen. A diffuse lower abdominal peritonitis was present. A sigmoid colostomy was performed and the peritoneal cavity was drained. Death on the ninth post-operative day. No autopsy.

This case was an inflammatory tumor resulting from a foreign body.

Case 9.—G. F., male, age 55, white, was admitted in October, 1935, with a four months' history of frequent and painful defecation. There was no history of blood in stools. Positive physical findings were confined to rectal examinations. Digital examinations showed hard, tender mass on the anterior rectal wall at tip of finger. Proctoscopic examination showed no ulceration; no bleeding. A biopsy specimen was reported as chronic inflammatory process. Roentgenologic examination of lungs, lumbar spine and pelvis showed no metastases. Temperature 99.6° F.; erythrocyte count, 4,400,000; hemoglobin, 86 per cent; leukocyte count, 11,700; polymorphonuclears, 85 per cent. Stool negative for blood by chemical examination. Preoperative diagnosis: Carcinoma of rectum.

Operation showed hard, fixed mass the size of an orange at rectosigmoid junction. Adjacent loops of small intestine were adherent to the mass. No free fluid; no palpable metastasis in liver. Condition considered inoperable carcinoma. Node removed from pelvis adjacent to mass. Sigmoid colostomy performed.

Pathologic report of this node, chronic lymphadenitis.

Readmitted in March, 1936, for proctoscopic examination. Twenty-six pound weight gain. Spinal anesthesia. Two proctoscopes inserted; one through anus and one through colostomy. Impossible to make the two proctoscopes meet. No erosion; no bleeding. On left side of rectum a hard mass, outside the gut, could be felt. No biopsy.

This case very suggestive of inflammatory tumor of rectosigmoid with cicatricial stenosis.

Case 10.—G. N., male, age 14, white, was admitted February 5, 1920, complaining of generalized abdominal cramps with vomiting. For the past four months he had had recurrent attacks similar to the present one. He was emaciated and somewhat anemic. The abdomen was symmetrical with some tenderness in the right lower quadrant where there was a mass. Temperature rose to 100° F. on several occasions. Pulse and respirations normal. Urine, negative; white blood cells, 14,000; polymorphonuclears, 65 per cent; red blood cells, 3,500,000; hemoglobin, 70 per cent.

At operation, February 12, 1920, a tumor involving the terminal portion of the ileum, cecum and appendix was found. The ileum and right half of the colon were resected, and an end-to-side anastomosis performed.

The patient developed a fecal fistula which persisted for nine months, and on two occasions he developed secondary abscesses around this fistula which required incision and drainage. The fistula finally closed and the patient was followed for five years. His only complaints during this time were irregular recurrence of pain in the right lower quadrant with opening of the fistula on two occasions.

The cecum, ileum and appendix were the seat of a chronic productive inflammatory reaction which was definitely not tuberculous. The cecal mucosa was ulcerated. There was a fistula between the terminal portion of the ileum and the cecum which was embedded in a mass of adhesions.

The origin of the inflammatory reaction in this case was unknown and it represents a case similar to those described under the heading of regional ileitis.

Case 11.—P. F., male, age 37, white, was admitted May 4, 1922, complaining of increasing constipation for five months. He has also had, during the last five weeks, irregular cramping pain particularly in the lower abdomen. He had lost approximately 40 pounds in two and one-half months. He was markedly emaciated and chronically ill. In the left upper quadrant there was an orange-sized mass which was fairly tender. Rectal examination, negative. Temperature, pulse and respirations, normal. Urine, negative; white blood cells, 9,000; polymorphonuclears, 82 per cent; red blood cells, 3,600,000; hemoglobin, 70 per cent. Stool negative for blood. Barium enema showed defective filling at the splenic flexure.

At operation, May 12, 1922, a large mass was found involving the splenic flexure of the colon. This was resected and a side-to-side anastomosis performed. The abdomen was closed with drainage. The patient died on the fourth postoperative day, having developed a severe pulmonary infection.

The wall of the large intestine was markedly thickened and firm, forming a tumor about five inches long and four inches in diameter. The mucosa was ulcerated. There was marked fibroblastic proliferation in the wall of the gut with infiltration with many plasma cells.

This was interpreted as a chronic productive inflammatory reaction probably on the basis of a colitis.

CONCLUSIONS

It should be emphasized that these tumors occur throughout the gastrointestinal tract and that, while the etiology varies, the pathology is essentially the same in all regions. It is our belief that incision and drainage alone is indicated in the presence of abscess, even though fistulae may persist. In the presence of intestinal obstruction nothing but conservative surgery should be carried out. In the absence of abscess, side-tracking and regional node biopsy carries a lower mortality and a lower incidence of complications than resection. The observation of Moschowitz and Wilensky, that the disease is often cured by this type of procedure, still holds good. In addition, conservatism provides the opportunity for subsequent operation when required by a confirmed diagnosis of malignant disease.

It is to be noted that the problem lies more in avoiding radical surgery with its high mortality in a condition not demanding it than in assuring radical surgery to those individuals who may not be benefited by it.

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REFERENCES

- ¹ Virchow: Virchows Archiv., 5, 335 ff., 1853.
- ² Moynihan, B. G. A.: Mimicry of Malignant Disease in the Large Intestine. Edinburgh Med. Jour., 21, 228, 1907.
- ³ Robson, A. W. M.: An Address on Some Abdominal Tumors Simulating Malignant Disease and Their Treatment. British Med. Jour., 1, 425, 1908.

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- Ibid.* The Hunterian Lecture, Duodenal Ulcer and Its Treatment. British Med. Jour., February 2, 248, 1907.
- ⁴ Braun, H.: Deutsch. Ztschr. f. Chir., **1**, 12, 100, 1909.
- ⁵ Giffin, H. Z.: ANNALS OF SURGERY, **53**, 533, 1911.
- ⁶ Proust and Lejars: Quoted by Coffen, T. H.: J.A.M.A., **85**, 1303, 1925.
- ⁷ Hamann, C. A.: ANNALS OF SURGERY, **51**, 782, 1910.
- ⁸ Lee, B. J.: ANNALS OF SURGERY, **65**, 265, 1917.
- ⁹ McGrath, B. F.: Intestinal Diverticulæ: Their Etiology and Pathogenesis. Surg., Gynec., and Obst., **15**, 429, 1912.
- ¹⁰ Telling: Lancet, March 21, 1908, **28**. Quoted by McGrath.
- ¹¹ Moschowitz, E., and Wilensky, A. O.: Non-specific Granulomata of the Intestines. Am. Jour. Med. Sci., **166**, 48, 1923.
- ¹² Barron, M. E.: Simple Non-specific Ulcer of the Colon. Arch. Surg., **17**, 355, 1928; and Surg., Gynec., and Obst., 870, May, 1930.
- ¹³ Mock, H. E.: Infective Granuloma. Surg., Gynec., and Obst., **52**, 672, 1931.
- ¹⁴ Wilensky, A. O.: Non-specific Granuloma of the Intestine. Med. Jour. and Rec., **135**, 445, 1932.
- ¹⁵ Raiford, T. S.: Arch. Surg., **25**, 148, July and August, 1932.
- ¹⁶ Erdmann, J. F., and Burt, C. V.: Non-specific Granuloma of the Gastro-Intestinal Tract. Surg., Gynec., and Obst., **57**, 71, 1933.
- ¹⁷ Crohn, B. B., Ginzburg, L., and Oppenheimer, G. D.: Non-specific Granulomata of the Intestines. ANNALS OF SURGERY, **98**, 1046, December, 1933.
- ¹⁸ Harris, Bell, & Brunn: Chronic Cicatrizing Enteritis. Surg., Gynec., and Obst., **57**, 637, 1933.
- ¹⁹ Jones, N. M., and Eisenberg, A. A.: Inflammatory Neoplasm of the Intestines Simulating Malignancy. Surg., Gynec., and Obst., **27**, 420, 1918.
- ²⁰ Bull, W. T.: Accidents Which May Follow Removal of Portions of the Omentum in Operations for Hernia. ANNALS OF SURGERY, **17**, 269, 1893.
- ²¹ Pack and Davis: Carcinoid Tumors of the Small Intestines. Am. Jour. Surg., **9**, 472, 1930.
- ²² Weinstein, M. L.: Lympho-sarcoma of the Jejunum. Am. Jour. Surg., **17**, 355, 1932.
- ²³ Mayo, C. H.: Quoted by Jones and Eisenberg.
- ²⁴ Kauffman: Lehrbuch der Spez. Path., **1**, Walter de Gruyter, Berlin, 1931.
- ²⁵ Harris and Rosenblum: Primary Carcinoma of Jejunum. Arch. Surg., **23**, 805, 1931.
- ²⁶ King, E. L.: Benign Tumors of the Intestines with Special Reference to Fibroma. Surg., Gynec., and Obst., **25**, 54, 1917.
- ²⁷ Liu, J. H.: Tumors of the Small Intestine with Special Reference to the Lymphoid Cell Tumors. Arch. Surg., **11**, 602, 1925.
- ²⁸ Fiedler, F. W.: Benign Tumors of the Small Intestines. Memphis Med. Jour., **9**, 185, October, 1932.
- ²⁹ Davies, J. H. T.: Proc. Royal Soc. Med., **26**, 128, 1932.
- ³⁰ Gregory, H. H. C.: Two Case Reports of Melena Caused by Innocent Growths of the Small Intestine. Brit. Jour. Child. Dis., **29**, 197, 1932.
- ³¹ Golob, M.: Infectious Granuloma of the Intestines with Special Reference to the Difficulty of Pre-operative Differential Diagnosis. Med. Jour. and Rec., **135**, 390, 1932.
- ³² Coffen, T. H.: Non-specific Granuloma of the Intestine Causing Intestinal Obstruction. J.A.M.A., **85**, 1303, 1925.
- ³³ Ewing, J.: Neoplastic Disease. W. B. Saunders, page 42, Philadelphia, 1928.
- ³⁴ Molesworth, H. W. L.: Granuloma of the Intestine. Brit. Jour. Surg., **34**, 21-370, 1933-1934.
- ³⁵ Gordon, D.: ANNALS OF SURGERY, **97**, 130, 1933.
- ³⁶ Hanford, Jannssen, and Eggers: Discussion of Gordon's Paper. ANNALS OF SURGERY, **97**, 130, 1933.

- ³⁷ Monsarrat: *British Med. Jour.*, **2**, 65, 1907.
- ³⁸ Rankin, F. W., and Major, S. G.: Tumors of the Mesentery. *Surg., Gynec., and Obst.*, **54**, 809, 1932.
- ³⁹ Rankin, F. W., and Newell, C. E.: Benign Tumors of the Small Intestine. *Surg., Gynec., and Obst.*, **57**, 501, October, 1933.
- ⁴⁰ Rankin, F. W., and Mayo, C., 2nd: Carcinoma of the Small Bowel. *Surg., Gynec., and Obst.*, **50**, 939, 1930.
- ⁴¹ Cave, H. W.: Tumors of the Small Intestine. *ANNALS OF SURGERY*, **96**, 269, 1932.
- ⁴² Ulman, A., and Abeshouse, B. S.: *ANNALS OF SURGERY*, **95**, 875, 1932.
- ⁴³ Jennings, J. E.: *ANNALS OF SURGERY*, **93**, 828, 1931.
- ⁴⁴ Hartwell and Cecil: *Am. Jour. Med. Sci.*, **140**, 174, August, 1910.
- ⁴⁵ Clifton, H. C., and Landry, B. B.: *Boston Med. and Surg. Jour.*, **8**, 197, July 7, 1927.
- ⁴⁶ Barker, L. F.: *Internat. Clin.*, September, 1931.
- ⁴⁷ Andrews, C.: Obstruction of the Small Intestine Due to Benign Granuloma. *Nebr. State Med. Jour.*, **17**, 106, 1932.
- ⁴⁸ Kolodny, A.: Infective Granuloma of the Stomach. *ANNALS OF SURGERY*, **102**, 30, July, 1935.
- ⁴⁹ Ashurst: *ANNALS OF SURGERY*, **47**, 300, 1908.
- ⁵⁰ Bockus, Henry L., and Lee, Walter Estell: Regional (Terminal) Ileitis. *ANNALS OF SURGERY*, **102**, 412-421, September 1935.

DISCUSSION.—DR. CARL EGGERS (New York) said that it would be helpful if a common terminology could be found for these conditions. The name proposed by Doctor Dudley, namely, "nonspecific granuloma" or "inflammatory tumors of the gastro-intestinal tract" may serve very well. It seems better than to have a specific name for inflammatory tumors in each section of the gastro-intestinal tract. Somehow he had never had under his care a patient with an inflammatory tumor of the lower ileum other than tuberculous. However, he had come in contact with inflammatory tumors of the pyloric region, so-called hypertrophic tumors or hypertrophic ulcers, as well as with inflammatory tumors of the cecum and especially the sigmoid.

The first pyloric case encountered was in a man who, four years previously, had had a diagnosis made of inoperable carcinoma of the stomach and a gastro-enterostomy with a Murphy button had been performed. He came in now with recurrence of his symptoms. It was learned that the button had apparently not passed. Roentgenologic examination showed a foreign body in his stomach. He was operated upon and the two cylindrical portions of the button, the so-called male and female part, were recovered from his stomach; the remainder seemed to have been digested. There was no sign of a tumor. The gastro-enterostomy was intact. The man died of postoperative pneumonia. At autopsy the steel spring of the button was found to be stuck in the pylorus; it had not shown in the roentgenogram. Since then he had seen a number of large tumors in this region. They bring out a point stressed by Doctor Dudley, namely, that a side tracking operation is safe and is an ideal procedure in these cases. Most cases are cured by a gastro-enterostomy, but one has to be sure not to overlook a carcinoma.

Two cases with large palpable tumors of the cecum were of interest. The first case of this type was seen many years ago. He had intestinal symptoms and a palpable mass. Various diagnoses were suggested, ranging from tumor of the colon to tumor of the kidney. The roentgenologic examination was not conclusive. At operation there was found a large tumor occupying the cecum and ascending colon, extending into the mesentery, and evidently inoperable. An ileocolostomy was performed, after which he was given some roentgenotherapy more as a palliative measure than

with the intention of curing the lesion, and he did very well. The mass disappeared completely and he has had no symptoms since.

Four years ago a second case came under observation which presented a large palpable tumor of the cecum, with obstructive symptoms. He was an old cardiac case. An ileocolostomy was performed as a preliminary procedure, with the intention of removing the tumor at a second stage. A few weeks later when his heart condition had improved, reoperation to remove the tumor was undertaken and it was found that the mass had disappeared. It has not recurred.

Both of these cases illustrate the value of a side tracking operation in the presence of these inflammatory tumors. Unfortunately we do not know the pathology of these cases, since no pathologic examination was possible. They were evidently large granulomata.

Inflammatory tumors of the sigmoid seem to be the most common, and one can distinguish two groups of cases. In some patients one has diverticula and diverticulitis; in others, there are large palpable tumors of the sigmoid in whom one does not see any diverticula in the roentgenograms or at operation. This constitutes a rather interesting group. Dr. Eggers has collected 51 personally observed cases of inflammatory conditions of the sigmoid giving symptoms sufficiently severe to require surgical consultation or operation. In most instances, consultation only. Sometimes these tumors were very large. In a few instances, a diagnosis of ovarian cyst or ovarian tumor was made in the beginning. Some have had very high fever, usually with a high leukocyte count. Another surprising feature has been the speed with which they may disappear after rest in bed, emptying of the bowel, and other measures. In a number of instances we operated and found a large tumor, which looked inflammatory, red, partly covered with fibrin and unlike carcinoma. If one has seen a number, one may differentiate with reasonable certainty. After making the diagnosis, the tumor, in some instances has not been resected, but has been replaced and the patients have recovered. The mortality connected with resection is known, and if one can recognize the tumor as inflammatory in character, one may be conservative.

He recalled an interesting case, seen in 1930, with a tumor which reached to the umbilicus. She had been in bed with fever for a few weeks. It had been diagnosed as a tubo-ovarian condition but on questioning, symptoms of an intestinal disorder were elicited. At operation a large tumor in the pelvis adherent to the bladder, anterior and lateral abdominal wall and adnexa was found. She had a very high leukocytosis—up to 50,000. The mass was apparently an inflammatory one. Resection was not performed, but the mass was liberated and placed in a more favorable position higher in the abdomen where it would not be so likely to reform adhesions. The lymph nodes of the mesentery which drained the tumor were cultured, but no growth obtained. After a prolonged convalescence the patient recovered and she has had no recurrence of symptoms since. During her convalescence she was given roentgenotherapy, which in some of these inflammatory conditions appears to be of value.

Doctor Eggers then presented a series of lantern slides in order to illustrate certain points connected with the diagnosis of sigmoiditis and diverticulitis, as well as its possible underlying pathology. The first was that of a patient who had been admitted on two different occasions, with several years' interval. Each time she presented a large palpable tumor which subsided in five or six days with rest in bed, application of an icebag and attention to the bowels. No diverticula were ever demonstrated.

The next showed a middle-aged female, who presented a tumor in the left lower abdomen with symptoms suggestive of a sigmoid lesion rather than a pelvic mass. The roentgenologic examination was reported negative. A year later she was seen again, and bearing in mind the previous negative roentgenologic finding, a diagnosis of pelvic disease was made. At operation a rather hard inflammatory tumor of the sigmoid was found. It was replaced and the abdomen closed without drainage. Subsequent roentgenologic examinations, especially after defecation, showed what was considered to represent a typical sigmoiditis. Four years have passed, and though the patient has had occasional intestinal symptoms, she has remained well. The modern technic of visualizing sigmoid lesions, particularly after defecation, is most important.

Another interesting case was one in whom a diagnosis of sigmoiditis had been made on the basis of intestinal symptoms and a palpable mass. It had been verified roentgenologically. His diet was regulated and mineral oil administered. A year later he was taken acutely ill, with what was thought to be acute appendicitis. Knowing that he had diverticula of the sigmoid, perforation of this segment of the gut was considered. There were signs of peritonitis over the entire lower abdomen. At operation fluid was evacuated, and the appendix removed. It did not explain the symptoms. The sigmoid was inspected. It was red, hard, and covered with fibrin. No gross perforation was seen; it was evidently closed off by fibrin. The tumor mass was replaced and the abdomen drained. He made a good recovery. Culture of fluid showed colon bacilli and streptococci. Intestinal symptoms, consisting of pain and vomiting, and suggesting obstruction, continued. A resection was performed about six months later with a good result.

A fourth case was that of an elderly male, in whom a diagnosis of carcinoma of the sigmoid had been made. He had pain, tenderness and a palpable mass. Roentgenologic examination demonstrated a small diverticulum next to the mass. Diagnosis of sigmoiditis was made and as the patient was not a good surgical risk, roentgenotherapy and observation were advised. He continues to remain well, six years later.

A fifth case illustrated the value of taking roentgenograms before and after defecation, as the lesion may show after defecation, when it does not do so before. This patient had a palpable tumor apparently with a perforation of the lumen of the gut into the mass. It was resected and found to be inflammatory. Careful microscopic studies had been made, and it had been determined that the lesion was the result of perforation of a diverticulum into the wall of the gut.

Dr. Eggers thought that in a case, such as that just cited, one may obtain a clue to the etiology of some of these inflammatory tumors of the gastro-intestinal tract. A foreign body may be considered to be the cause in some cases. A few of the cases, cited herewith, may have had a mucosal ulcer as the port of entry. In two instances it was apparently a perforation of a diverticulum into the wall of the gut. The mucosa was normal, but there was an infected diverticulum in the wall. It was the speaker's feeling that infected diverticula were probably frequently the cause of inflammatory intestinal tumors. One may visualize the process as follows: We usually picture a diverticulum as projecting beyond the serosa of the gut wall. Perforation of such a diverticulum may form a local abscess or peritonitis. However, a diverticulum has a beginning, and before it projects beyond the serosa, it must work its way between the fibers of the gut wall. At any time during this process, stagnation and infection may occur. As the result of the increased tension it may perforate in different directions. The

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reason many of these inflammatory tumors subside is because they perforate into the lumen and drain that way. Others perforate into the wall, spread along between the layers and form the large hard tumors we sometimes see. Still others perforate externally and form a local abscess or peritonitis.

DR. PERCY KLINGENSTEIN (New York) thought that Doctor Dudley had brought out very important considerations in connection with the cases cited. In the future, now that attention has been drawn so actively to this condition, with refinements in roentgenology, so that the small intestine will become less a silent field in roentgenologic study of the abdomen, more accurate preoperative diagnosis will be made. The lesions, as Doctor Eggers stated, do tend to localize on the left side, yet in Doctor Klingenstein's experience there have been a number localized on the right side. The factor accounting for this is not known. A more exact classification could be made if the etiology were more definitely understood.

DR. SEWARD ERDMAN (New York) asked Doctor Dudley whether, in looking up the literature, he had noted that the majority belonged in the cancer age group. If so, this would be in contrast to the many patients shown during the meeting who were young, in a number of instances. Doctor Erdman was also surprised to observe that so many of the cases were on the right side.

DR. GUILFORD S. DUDLEY (closing) answered that his impression regarding age has been that those inflammatory lesions involving the small intestine and particularly the ileum, or ileum and cecum, tend to be in a younger age group, whereas those involving only the large intestine tend to occur in older patients, that is, in the cancer age group. Common terminology was the thought uppermost in mind in captioning the paper presented. "Inflammatory Tumors of the Gastro-intestinal Tract," being chosen in preference to one that would have been confined to any particular portion of the tract.

DR. LAURENCE MISCALL (closing) pointed out that in the literature the occurrence of inflammatory tumors throughout the gastro-intestinal tract is generally recognized. Many authors have noted minor variations in the pathologic picture and an abundance of etiologic factors in the different parts affected. The common occurrence of fistulae and abscesses complicating radical operative procedures on inflammatory tumors of the gastro-intestinal tract is impressive. These complications have often required secondary or tertiary reoperation. The conservative procedures seem indicated: First, they may cure the patient. Second, they may reduce the incidence of complications. Third, if reoperation becomes necessary it may be carried out when the acute infectious stage may have subsided and been replaced by fibrosis.

NONSPECIFIC GRANULOMATA OF THE INTESTINE*

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THE appended case reports are presented as instances of nonspecific granulomata of the intestines. The first five are examples of regional ileitis, a pathologic and clinical entity described by Crohn, Ginzburg and Oppenheimer,¹ in 1933. While the various clinical courses of this condition may be divided arbitrarily into groups, according to their symptomatology, the disease is so protean in its clinical manifestations that it is rarely diagnosed preoperatively. The diagnosis in Case 1 was made by the roentgenologist, and in Cases 2, 3, and 4, only at the time of operation. The surgical treatment is far from standardized and the efficacy of the various procedures employed will be determined, and correctly evaluated, only after careful follow-up examinations have been made over long periods of time.

The type of operation for regional ileitis should be largely determined by the extent of the pathology of the diseased ileum. Undoubtedly some of the proven milder cases result in spontaneous recovery, but it would seem better judgment in the early ones to divide the ileum through healthy bowel and side-track the fecal current. A secondary resection may be performed later should the disease progress. If, however, the ileitis has advanced to marked stricture and internal fistula formation, as was present in Cases 3 and 4, resection of the involved bowel in one stage is probably the safest procedure. Radical resection, however, apparently does not guarantee against recurrence of this condition because cases of this nature have already been reported. Case 5 is one of this type. In 1931, an ileocecal resection for nonspecific terminal ileitis was performed, removing about 40 cm. of the ileum, the cecum, and portion of the ascending colon. Roentgenologic examination, in 1933, showed some irregularity of the anastomosed terminal ileum, but it was not until 1936 that the patient began to complain of increasing abdominal pain. At this time the roentgenologic examination revealed marked changes in the terminally anastomosed ileum, which operation verified. The ileum was divided again through healthy bowel, and an ileosigmoidostomy was performed. The prognosis in these particular cases must be guarded.

Case 6 is presented as another type of nonspecific granuloma of the intestines, classified by Ginzburg and Oppenheimer as belonging to the group of localized hypertrophic colitis. Similar to the majority of these cases, this patient gave a history of a mild colitis accompanied by temperature. Physical examination disclosed a palpable mass in the right lower quadrant. Roent-

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genologic examination revealed a constricting lesion confined to the right half of the bowel. Because of the patient's poor general condition, it was decided to perform a two stage procedure for resection of the right half of the colon. Following division of the terminal ileum and performance of an ileosigmoidostomy, the patient improved so markedly that the second stage was deemed unnecessary. An ileosigmoidostomy was elected in preference to an ileotransverse colostomy because it was felt that the right half of the colon would be put at almost complete rest by this procedure. Subsequent roentgenologic examinations by means of a barium enema apparently supported this contention.

CASE REPORTS

Case 1.—No. 391710: M. K., female, age 43, was admitted to the surgical service of the Mount Sinai Hospital April 4, 1936. One year before admission, the patient experienced several attacks of abdominal pain associated with nausea and diarrhea, each of which lasted two weeks. During the past six months she had several episodes of abdominal pain associated with nausea, vomiting and diarrhea, usually following the ingestion of spicy foods. Coincidentally, she noticed pain and discomfort about the anus, and small amounts of blood in the bowel movement.

Physical Examination.—Negative except for the presence of hemorrhoids. Sigmoidoscopy was negative. A barium enema was given and although the roentgenogram of the colon was negative, the ileum showed definite pathology. The gastro-intestinal series, with special reference to the ileum, showed the presence of an ulcerative lesion involving more than two feet of the ileum, not involving the cecum.

Operation.—May 15, 1936. Under spinal anesthesia, exploration revealed the typical findings of a regional nonspecific ileitis involving about 18 inches of the terminal ileum. This was evidenced by a marked leathery contraction of the bowel with intervals of several strictures and intervening dilatation of the diseased bowel. The mesentery was edematous, thickened and shortened, and there was marked enlargement of the mesenteric nodes. A typical side-to-side isoperistaltic ileosigmoidostomy was performed after division of the ileum proximal to the lesion. The postoperative course was uneventful, and the patient was discharged April 26, 1936.

The patient was last seen March 4, 1937. She had gained about ten pounds in weight and felt absolutely well. Her bowels moved three times a day and the stools were normal in consistency. She had had no recurrence of the cramps. Roentgenologic examination, following a barium meal, disclosed no abnormality, other than the defect occasioned by the ileosigmoidostomy.

Case 2.—No. 377721: M. C., male, age 30, was admitted to the Mount Sinai Hospital April 3, 1935. He had been a patient one week prior to the present admission. At this time he had suffered an attack of upper abdominal pain with associated digestive disturbances. He had never been frankly jaundiced although the icteric index was 16. The van den Bergh direct was delayed positive, and blood bilirubin 0.7 mg. The gall-bladder roentgenograms were negative. The diagnosis upon discharge was cholelithiasis, chronic cholecystitis and possibly a common duct calculus with cholangitis. Six days after discharge from the hospital, he suddenly experienced another severe attack of sharp epigastric pain with nausea and vomiting. During the attack, which lasted one day, he felt feverish but had no chills. Upon his second admission, he was acutely ill and vomited bile stained material frequently. The temperature was 100.2°F., pulse 96. The hemoglobin was 85 per cent. The white blood count and differential were normal. The urine contained a trace of bile. The blood Wassermann was negative, and the blood chemistry normal. There were distention and diffuse tenderness over the entire abdomen with the maximum tenderness localized in the right upper quadrant.

The clinical impression was that the patient was suffering from either a penetrating

peptic ulcer, or an acute cholecystitis. By midnight, on the day of admission, the abdominal pain had become excruciating, and temperature had risen to 103°F. The entire abdomen was rigid. Repeated abdominal punctures were negative, and roentgenologic examination failed to disclose the presence of air under the diaphragm, but showed some dilatation of the small bowel. The patient's general condition gradually improved, the temperature subsided, and the abdomen became soft, although at times there were episodes of abdominal pain. Stools were guaiac positive on one occasion. At this time, the patient was noted to have a leucopenia. The white count was about 4,000, 40 to 50 per cent lymphocytes. The red blood cells appeared normal. The fragility test was found to be increased above normal. The blood amylase was 3.5; the icteric index, 11, van den Bergh direct was negative, and blood bilirubin 0.2 mg. Duodenal drainage was performed and bile obtained, microscopic examination of which failed to reveal pus cells, bacteria or cholesterol crystals. A gastro-intestinal series failed to show any evidence of abnormality. Because of the persistence of the abdominal pain, and the inability to make a definite diagnosis, it was felt that surgical intervention was justified.

Operation.—May 1, 1935. Under spinal anesthesia, an upper right rectus muscle splitting incision was made. The gallbladder was found to be markedly distended, and contained about 60 cc. of dark green bile. There were no stones. It was adherent to the transverse colon and duodenum by innumerable adhesions. The common duct appeared normal, as did the pancreas. There were numerous recent adhesions in the lower abdomen suggestive of a peritonitis, and there was a chronically inflamed appendix. About eight inches from the cecum, there was found a firm edematous, irregular mass in the ileum almost occluding the lumen at this point. Proximal to this, for about 12 inches, the ileum was dilated and its walls markedly hypertrophied. The mesentery of the diseased bowel was edematous, thickened and shortened. The mesenteric nodes were enlarged and acutely inflamed. The lesion was apparently that of terminal ileitis.

A cholecystostomy was performed and the ileum was divided through an apparently normal bowel proximal to the lesion. A side-to-side isoperistaltic ileotransverse colostomy was performed. The postoperative course was complicated by a mild, nonsuppurative, left-sided parotitis, and a slight wound infection. He was discharged May 17, 1935.

The patient was last seen November 25, 1936. He had gained 12 pounds in weight and had no complaints. Roentgenologic examination October 23, 1935, by means of a barium meal, showed nothing unusual.

Case 3.—No. 372484: S. K., male, age 27, was admitted to the surgical service of the Mount Sinai Hospital October 22, 1934. For the past five years he had been suffering from vague abdominal pains. About one and one-half years ago these pains seemed to localize in the right lower quadrant; he was told he had a chronic appendicitis. In April, 1924, the pain became more severe and colicky, and roentgenologic examination showed a lesion which was interpreted as a chronic ileal intussusception. Since then he has had severe attacks of acute pain during which his abdomen became distended, and when seen in one of these episodes, peristalsis was visible.

Physical Examination on October 2, 1934, revealed an emaciated young man who appeared chronically ill. Examination of the abdomen revealed marked distention and visible peristalsis. The hemoglobin was 90 per cent, red blood count 5,200,000, white blood count 29,000, polymorphonuclears 90 per cent. The urine was negative.

Operation.—October 25, 1934. Under spinal anesthesia, through a lower right rectus splitting incision, a hard fibrotic mass occupying the ileum and covered by omentum was found about seven feet from the ileocecal junction. Proximal to this there was a huge dilatation of the intestine with marked hypertrophy of its wall, the diameter of the ileum at this point measuring about five inches. This fusiform dilatation extended orally for about 12 inches and its termination was marked by another fibrotic contraction. The mesentery of the involved bowel was thickened and edematous with marked enlargement of the mesenteric nodes. Beyond this segment the intestine appeared normal, al-

though the musculature appeared hypertrophic. An examination of the remainder of the intestine revealed no further pathology.

An intestinal resection of about two feet of diseased bowel was performed with a side-to-side ileo-ileal anastomosis. The wound was closed in layers and without drainage. The postoperative course was smooth. The pathologic report was "regional ileitis of the ulcerogranulomatous type, with foreign body reaction and early fistula formation." The wound healed by primary union and the patient was discharged November 8, 1934.

The patient was last seen April 27, 1937. He had gained ten pounds in weight and had no complaints. His bowels moved once a day and were normal in consistency.

Case 4.—No. 399413: S. D., male, age 29, was admitted to the Surgical Service of the Mount Sinai Hospital October 7, 1936. During the past two months, he had become markedly constipated, and during this period there had been a loss of 35 pounds in weight, increasing weakness, anorexia, and occasional abdominal cramps, which began in the umbilical region and radiated to both lower quadrants. A week before admission, he had a mild attack of diarrhea, but at no time were his stools bloody or tarry.

Physical Examination disclosed a rather anemic, chronically ill male. The general examination was negative, except that in the midline above the pubis there was an irregular, rather fixed mass the size of a lemon. On rectal examination, there was felt a hard, irregular mass adherent to the anterior rectal wall which gave the impression of a malignancy of the rectosigmoid. Proctoscopic examinations on several occasions, however, failed to reveal any pathology. The patient left the hospital against advice, and was readmitted November 4, 1936, having spent several weeks in rest and forced feeding and had gained 11 pounds in weight. He developed no new symptoms other than the occurrence of a slight dysuria and dribbling at the end of urination. Roentgenologic examination showed no abnormality either in stomach, duodenum, small intestine or in the colon.

Operation.—November 4, 1936. Under spinal anesthesia, the abdomen was opened through a left para-umbilical muscle splitting incision. The entire pelvis was found occupied by a large mass of matted small intestine adherent to the peritoneum over the sacrum, the base of the bladder, and to the sigmoid by firm, dense adhesions. Upon liberating these, the matted mass of intestines was found to extend from the ileocecal junction proximally for two feet; the appearance was typical of regional ileitis. The cecum appeared normal. A typical ileocecal resection was performed, dividing the ileum through normal bowel and resecting about one-half of the ascending colon. A side-to-side isoperistaltic ileosigmoidostomy was performed and the wound closed without drainage. The pathologic report was chronic and acute ulcerative ileitis with conspicuous fibrosis and stenosis, ileo-ileal fistula, and chronic peritonitis with foreign body reaction. The postoperative course was normal, except for a slight superficial wound infection, and he was discharged on the sixteenth day.

The patient was seen April 15, 1937, at which time the wounds were healed. The bowels were regular, moving three times a day.

Case 5.—No. 400559: H. C., male, age 37, was admitted to the Surgical Service of the Mount Sinai Hospital November 5, 1936. Eight years before, January 18, 1928, he had been operated upon at the hospital following a three weeks' history of abdominal pain, which, during the latter part of the illness, localized to the right lower quadrant. At operation, a large mass, the size of a grapefruit, was found which consisted of cecum, appendix, terminal ileum, and an adherent loop of sigmoid. The appendix, which was acutely inflamed, was found lying in the mesentery of the terminal ileum, which was almost two inches thick. The appendix was removed and drainage instituted.

Eight months after discharge, the abdominal wound, which had closed completely, again began to drain grayish fluid and continued to do so for a period of two months, when it healed spontaneously. Two years later, May 5, 1931, he entered the hospital for an abdominal wall abscess in the region of the scar. This was incised and a fistulous tract found, which, after lipiodol injection, was seen to lead down to the region of the cecum,

the lipiodol entering the cecum and the ascending colon. The fecal drainage ceased and patient was discharged, only to return five months later with a fecal fistula. Because of the induration and inflammatory reaction about the sinus, he was advised to return after this had subsided for operative intervention.

Operation.—October 30, 1931. There were extensive adhesions binding the small intestine and cecum to each other and to the anterior abdominal wall. The fistulous tract was found leading down, not to the cecum but to the terminal ileum, about two inches from the ileocecal junction. A mass was felt in the ileocecal region which was found to be for the most part thickened, indurated, edematous and hyperplastic ileum, extending about 30 cm. from the ileocecal junction. The cecum and ascending colon appeared grossly free, except just at the region of the ileocecal valve. About 40 cm. of ileum, cecum and 10 cm. of ascending colon were resected, and a side-to-side ileotransverse colostomy performed. Drains were placed in lumbar gutter. The pathologic report was "hyperplastic granuloma of the terminal ileum with fistula."

The postoperative course was quite uneventful. He was discharged on the eighteenth postoperative day, November 22, 1931, with the wound healed. Since his discharge from the hospital five years ago, he has been observed every six months in the Surgical Follow-Up Clinic. He has felt perfectly well with the exception of occasional pain in the abdomen. The bowel movements have been watery, but contained neither blood nor pus and were never more than three a day. His appetite is good and there has been no weight loss. On his last visit to the Follow-Up Clinic three months ago, he complained of increasing pain in the abdomen, and a gastro-intestinal series showed a narrowing of the lumen at the part of the bowel in the region of the anastomosis, typical of terminal ileitis. He was advised to enter hospital for operation.

Operation.—November 7, 1936. Under spinal anesthesia, the abdomen was opened through a left para-umbilical rectus muscle splitting incision. The previous ileocolostomy stoma was found without difficulty. The colonic portion of stoma was soft and appeared normal. Eighteen inches of the previously anastomosed terminal ileum showed the characteristic lesions of so called regional ileitis. The intestine was enlarged and indurated; the surface was dull, and had a leathery feel. There was no evidence of either stricture or fistula formation. The mesentery was markedly thickened, shortened, and edematous. The lymph nodes showed definite hypertrophy. Beyond this 18 inches of terminal ileum, the bowel appeared normal. The normal ileum was divided two feet from the ileotransverse colostomy together with its mesentery, and the proximal portion of the ileum, after both ileal ends had been closed, was anastomosed to the sigmoid by a side-to-side isoperistaltic ileosigmoidostomy. The wound was closed in layers without drainage.

Following operation, patient made an uneventful recovery and was allowed up on the tenth postoperative day. At present, he has two bowel movements a day, which are slightly watery in consistency.

The patient was again seen January 21, 1937, at which time he had gained seven pounds in weight. He was having three bowel movements a day, the consistency of which was gradually becoming thicker.

Case 6.—No. 378320: C. W., male, age 16, was admitted to the Surgical Service of the Mount Sinai Hospital April 1, 1935. He had been in this hospital a year previously with lobar pneumonia. He had been perfectly well until three months before admission, when he began to experience diarrhea and tenesmus. For three months, he had had transient pain in the right lower quadrant, usually unrelated to meals or bowel movements. He had been treated in the Out-Patient Department where the diarrhea had been moderately controlled. He had lost 15 pounds in weight in three months.

Physical Examination.—He appeared asthenic and somewhat emaciated. There was moderate tenderness and slight rebound tenderness in the right lower quadrant and no palpable masses. Rectal examination revealed slight tenderness on the right. Hemoglobin 72 per cent; white blood count 19,600, polymorphonuclears 72 per cent. Temperature 101° F. The stool was guaiac-positive and showed many red blood cells and

white blood cells on microscopic examination. The blood Wassermann was negative. The blood agglutinations for dysentery were negative; stool culture yielded only *B. coli* and enterococcus. Sigmoidoscopy revealed a very finely granular mucosa in a few spots, but for the most part the only abnormality noted was a moderate congestion. It was considered that these represented only minimal lesions of a possible mild ulcerative colitis. Barium enema revealed an irregular constricting lesion of both the ascending colon and hepatic flexure, markedly obstructing the passage of barium. Because of obstruction, it was not possible to fill the cecum completely, but the impression was gained that there was also a narrowing of the cecum and spasm and perhaps some narrowing of the terminal ileum. A few diverticula of the descending colon were noted.

The patient ran a persistently low grade febrile course. In the right lower quadrant, a small tender sausage-like mass gradually became more noticeable. Because of non-bloody diarrhea, palpable mass, and right lower quadrant pain and tenderness, it was felt that there was probably present a localized granuloma rather than an ulcerative colitis. The von Pirquet test was negative, but, nevertheless, the possibility of a hypertrophic tuberculosis of the large intestine could not be excluded. Examination of concentrated stool was negative for tubercle bacilli.

Operation.—April 20, 1935. Under spinal anesthesia, Dr. Leon Ginzburg performed a celiotomy through a four inch left rectus incision. The terminal ileum appeared normal, but the cecum and ascending colon were the seat of extensive inflammatory disease and were covered over by omental adhesions. No formal exposure of these areas was attempted. The ileum was divided about six inches from the ileocecal junction, and a side-to-side ileosigmoidostomy was performed. Following operation, patient ran an uneventful course and was discharged.

Since discharge, the patient's improvement has been amazing. When last seen, November 25, 1936, he had gained 30 pounds in weight, and the mass palpable in the abdomen before operation could hardly be felt. He was symptom free. Bowels are regular, once a day, and normal in appearance. Roentgenologic examination showed evidence of the ileotransverse colostomy. The proximal half of the colon filled fairly well. The barium, as it filled the colon, proceeded so rapidly that it was impossible to see the stoma clearly. After evacuation the cecum and the ascending colon were seen and appeared somewhat narrowed, but there was no evidence of a mass in the lumen of the cecum. The part of the ileum visualized showed no definite abnormality.

REFERENCE

- ¹ Crohn, B. B., Ginzburg, L., and Oppenheimer, G. D.: Nonspecific Granulomata of the Intestines. *ANNALS OF SURGERY*, 98, 1046, December, 1933.

DISCUSSION.—DR. HENRY W. CAVE (New York) cited what he believed to be a rather unusual case of terminal ileitis operated upon by him some years ago. He presented it for the reason that the specimen shows rather discrete granulomatous areas appearing almost like ulcerations in the terminal ileum, with one large encircling, constricting, granulomatous involvement. The patient was a man, age 31, who came to the hospital complaining of symptoms of acute intestinal obstruction, and a very rapid loss of weight. For the past three and one-half months he had passed considerable amounts of blood and mucus by rectum. At operation a thickened terminal ileum with granulomatous ulcerations was found. Doctor McCallum, who at that time was pathologist of the College of Physicians and Surgeons, was interested in this specimen. He made cultures and sections and finally came to a diagnosis of what he called a chronic ulcerative infectious granuloma of the terminal ileum.

DR. RALPH COLP (New York) closing said: In regard to Doctor Cave's mention of the fact that the divided sigmoid is rather difficult to close, espe-

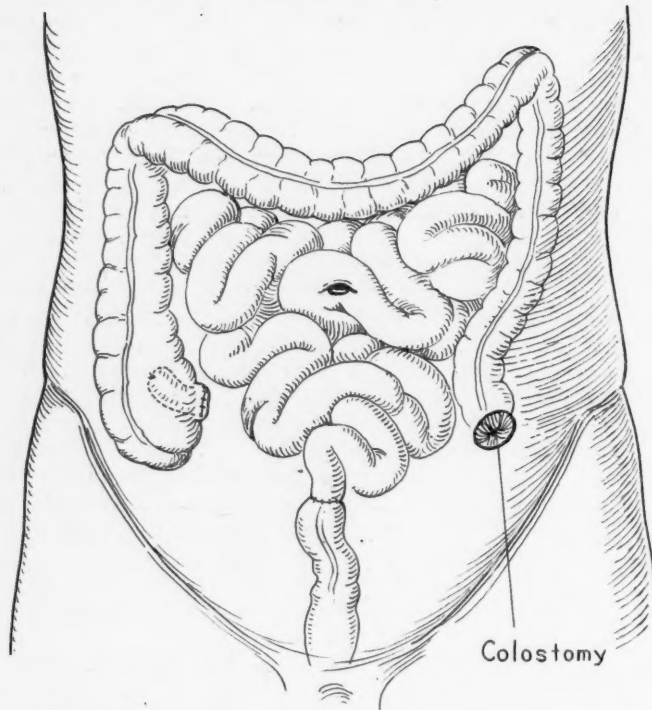


FIG. 1.—The von Beck operation for colonic exclusion in cases of ulcerative colitis.

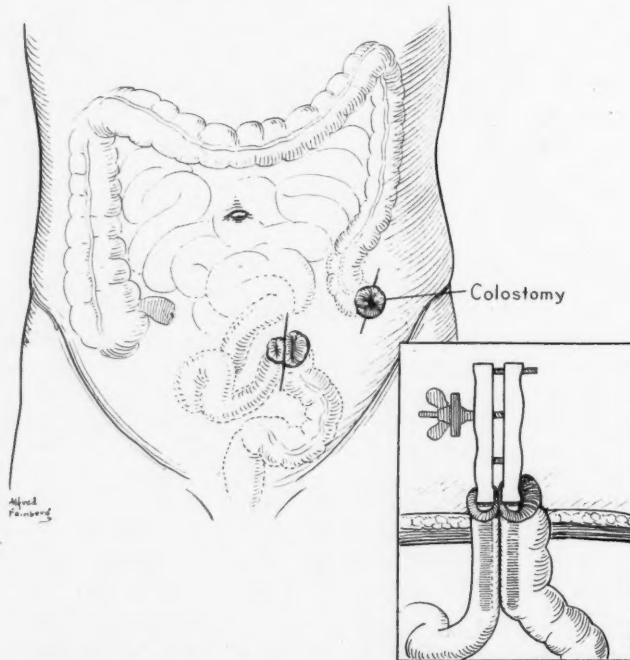


FIG. 2.—Colp's modification of the von Beck operation.

cially in cases of ulcerative colitis in which the rectum is not particularly involved, von Beck,¹ in 1913, reported an operation in cases of ulcerative colitis in which he divided the ileum near the ileocecal junction, and the colon at the sigmoid. The terminal ileum was closed and the proximal loop of colon was brought out as a colostomy, thus isolating the colon. He then recommended the anastomosis of the proximal ileum to the distal segment of the sigmoid by end-to-end suture (Fig. 1). Doctor Colp said the teaching in the past had been that intraperitoneal anastomoses are rather dangerous and should be avoided whenever possible. In a recent case, however, he had employed a procedure similar to the von Beck operation, but with modifications. The ileum was divided and the proximal colon was brought out as a colostomy, thus isolating the colon. Then he brought the proximal ileum out, through a left rectus incision, as an ileostomy, and the distal portion of the sigmoid out as a sigmoidostomy, approximating the intraperitoneal portion of both loops by interrupted serosal sutures (Fig. 2). The sigmoid and rectum are put at rest for any desired period, and, if multiple polypi are present, a sigmoidoscope may be introduced through the rectum and through the sigmoidostomy, and any polypi which may be present may be fulgurated. At some future time, provided the general condition of the patient is satisfactory, the spur between the ileum and sigmoid may be crushed, and an extraperitoneal closure performed. In that way the danger of intraperitoneal leakage is avoided. The isolated colon may then be removed, if necessary.

REFERENCE

- ¹ Beck, Bernhard von: *Beitrage zur Klinische Chirurgie*, 84, 339-343, 1913.

THE SO-CALLED HEPATO-RENAL SYNDROME

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SINCE 1924, when Heyd^{24, 25} called attention to the unusual postoperative course pursued by some patients after gallbladder surgery, there have appeared many articles on this subject, a careful analysis of which indicates that a few important points have been presented by three or four contributors and that most of the remaining articles contain confirmatory experiences by their authors.

It will be remembered that Heyd in his original and subsequent papers^{24 to 29} described a series of postoperative complications other than those which may reasonably be expected, as, for instance, hemorrhage, shock, gastric dilatation and embolism in the first 24 hours, and infection resulting in peritonitis or abscess formation in the succeeding 48 to 72 hours. He divided these unusual cases into three clinical groups:

Group I.—After a simple cholecystectomy in a patient in good general condition and whose preoperative studies have indicated competent renal, cardiac and respiratory function, recovery from the anesthetic is unduly delayed. The patient remains semicomatose for four to six hours, develops a talking delirium, subsultus tendinum, rapidly passes into coma with high temperature and dies.

Group II.—In this group, the patients have had a rather severe form of biliary infection with a history of jaundice and possibly a previous gallbladder operation. Following a choledochotomy with common duct drainage, the postoperative progress seems satisfactory for 36 to 48 hours. The patient then becomes irritable and nervous and passes into a pronounced vasomotor collapse with cold clammy extremities, and death finally supervenes. This clinical course was noted by Heyd in spite of a definitely diminishing jaundice and ample renal function. He considered these cases to be due to the liberation of some pancreatic toxins with inadequate liver protection. These patients did not exhibit alkalosis as did some in Group I.

Group III.—In a series of patients admitted with a clinical picture of calculus cholangitis, pancreatitis or, rarely, carcinoma of the head of the pancreas, operation was undertaken for the relief of these conditions and included, often, the institution of biliary drainage, either externally, or internally by cholecystogastrostomy. The immediate postoperative course seemed satisfactory. Icterus diminished appreciably and dehydration was overcome. If external biliary drainage was utilized, the patient was refed his own bile. After five or six days, in the presence of a constantly diminishing jaundice,

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these patients became somnolent, and soon passed into a state of coma which ended in death.

Heyd excluded infection as the cause of the syndrome presented in Group III, although his articles contain little mention of autopsy findings. He presented the theory that an increased burden was thrown on an already compromised liver of detoxifying a further increment of poisonous products and that the liver was unable to perform this function, resulting in a progressive exhaustion of liver capacity. In support of this view, he quoted Graham's¹⁵ work which stressed the frequent association of disease of the gallbladder and definite evidence of hepatitis. May we, at this time, call attention to the paper of Colp, Doubilet and Gerber¹⁰ whose findings are at some variance with those of Graham. They performed liver biopsies in 49 cases of acute and chronic cholecystitis with and without jaundice. Studies with finer histologic technic revealed no changes in the liver cells in biliary tract disease without jaundice. Focal liver cell degeneration seen in cases with jaundice represented, in their opinion, a reaction to bile stasis and was in no way related to the primary disease of the gallbladder. They believe that the periportal infiltrations observed in biliary tract disease are not specific of the disease but represent a reaction of the liver to extrahepatic infection. They conclude that hepatitis is not an accompaniment of cholecystitis as evidenced by the absence of inflammatory and parenchymal changes in the liver.

Heyd's observations aroused considerable discussion and there soon appeared a series of communications which more or less corroborated his clinical findings. Boyce and McFetridge^{3 to 7} feel that the so-called "liver deaths" after biliary surgery fall into two distinct groups:

Group I.—Death occurs shortly after operation with hyperpyrexia as the outstanding symptom and degenerative changes in the liver the only positive finding at autopsy.

Group II.—Death is deferred for 10 to 14 days when uremic symptoms predominate and postmortem examination reveals the degenerative liver damage plus similar degenerative changes in the convoluted tubules of the kidneys.

They attempted to reproduce these clinical syndromes experimentally, but were successful with Group II only. Using dogs, they ligated the common duct and maintained the obstruction for 18 days. Following release of the obstruction, the clinical picture presented by the cases in Group II was reproduced. Urinalysis and blood chemistry revealed the changes characteristic of an acute renal insufficiency. All the animals died in uremic coma and autopsy revealed the degenerative changes in the liver and kidneys seen in humans.

These authors contend that the release of the biliary obstruction rather than the obstruction itself is responsible for the fatal outcome in some cases of biliary surgery. The hepatic changes present in biliary disease are aggravated in some cases by the surgery instituted to relieve it, which imposes upon an already damaged liver an intolerable burden. This includes anesthesia, surgical trauma, a drop in intra-abdominal temperature and changes in intra-

hepatic and biliary pressure. They state that, as a result of the degenerative hepatic changes, seen also in cases of liver injury, hyperthyroidism, intestinal obstruction and burns, there is released into the circulation a toxic substance which is presumed to be a water-soluble foreign protein. When, after liver function fails, the kidneys take up the function of detoxification, there is resulting damage to their convoluted tubules, through which foreign proteins are excreted. These authors conclude that the hepato-renal syndrome is a single pathologic process of which the kidney disturbance represents the second stage. In view of the fact that most of these cases must, by inference, have a considerable degree of impairment of hepatic function, these authors suggest preoperative renal function tests as an indication of liver function, with the hope that these tests may actually reflect the efficiency of the liver. The same suggestion was made by Wilensky and Colp,⁴¹ in 1927.

On the other hand, the observations of Helwig and Schutz¹⁹ are worthy of note. In those cases coming to autopsy, they were struck with the fact that most of the definite pathologic findings were confined to the liver and kidneys. The liver usually appeared enlarged, presented fatty degeneration, cloudy swelling and polymorphonuclear leukocytic infiltrations with focal hemorrhages and parenchymatous cell necrosis. The kidneys were usually enlarged. Histologically, there was evident necrosis of the tubular epithelium. On the basis of the clinical course of a patient who received a laceration of the liver in an automobile accident and who developed symptoms identical with those under discussion and, also, because of the report of a similar instance of liver trauma by Furtwaengler, Helwig and Schutz conducted a series of experiments on dogs which consisted essentially of pulpification of most of the liver. Those animals that died within 12 hours from hemorrhage and shock were found to have albumin, casts and red blood cells in the urine. Those that survived the operation showed a rise in blood nitrogen, albumin, casts and red blood cells in the urine and progressive oliguria. In the first group, autopsy disclosed degeneration of the kidney epithelium and hemorrhagic necrosis of the liver. In another series of experiments, the same results were obtained by ligation of the hepatic artery which caused primarily a liver necrosis.

The clinical behavior in these traumatic cases and their similarity, both clinically and at necropsy, to those described by Heyd and others, have led these authors to assume that liver damage, whether traumatic or infectious in origin, produces a selective toxin which may severely damage the kidneys. In view of the fact that this syndrome has always followed damage to the liver and has occurred in individuals with previously normal kidneys (determined by kidney function tests), they believe that the pathologic changes in the kidney are secondary to the liver changes and are dependent upon a specific toxin elaborated in the course of liver cell destruction.

Our interest in this mysterious syndrome was recently intensified by the clinical course and subsequent pathologic studies of a patient who was operated upon for calculus gallbladder and bile duct disease. We believe that this case is of considerable importance: First, because of the careful studies conducted

both before and after operation; and second, because the autopsy findings are at such variance with those reported in the literature on the subject.

Case Report.—Hosp. No. 375648: R. B., white, female, married, age 54, was admitted to the Mt. Sinai Hospital January 14, 1935. Her personal, family, and past histories were irrelevant. Her present illness began two years before admission, with pain in the right upper quadrant which radiated around to the back. The pain was always related to the ingestion of fatty foods. These symptoms occurred only rarely after a self-imposed fat restricted diet. During the period of her present illness she had lost 30 pounds in weight. She also suffered from generalized pruritis and was told she was a diabetic. During the year prior to admission, and especially in the latter half, she experienced frequent attacks of abdominal pain associated with jaundice, fever, and occasional chills. The last episode of jaundice occurred one week before admission to the hospital. At no time was the jaundice pronounced. With the subsidence of the pain the jaundice rapidly disappeared.

Physical Examination disclosed a moderately obese woman whose skin presented a yellowish color. The conjunctivae and sclerae, however, were not icteric. There was a herpes simplex on the upper lip. Her heart and lungs were negative. The abdomen was soft not distended. There was tenderness in the right upper quadrant and epigastrium, and a mass which was thought to be gallbladder was palpable as far as the umbilical line. There was no evidence of ascites. Oral cholecystography failed to visualize the gallbladder. No evidences of gallstones were seen. The clinical diagnosis on admission was chronic cholecystitis and cholelithiasis with hydrops of the gallbladder.

Laboratory Data: Hemoglobin 90 per cent; white blood cells 9,000, of which 68 per cent were polymorphonuclear neutrophils, 26 per cent lymphocytes, 4 per cent monocytes, and 2 per cent eosinophiles. The blood smear appeared normal. The stools were colored and contained bile and urobilin. Guaiac test for occult blood was faintly positive. The urine was always negative for sugar, acetone, and diacetic acid. The specific gravity varied from 1016 to 1020: albumin negative. Microscopic examination negative. On three occasions before operation, bile in the urine was reported 1 plus. Urobilin on four occasions was present 1:20. The Janney test for glucose tolerance evoked a normal response. The blood Wassermann was negative. Blood chemistry studies revealed the following:

Urea nitrogen:	9 mg. per 100 cc.
Sugar:	110 mg. per 100 cc.
Cholesterol:	275 mg. per 100 cc.
Cholesterol ester:	145 mg. per 100 cc.
Icteric index:	15
van den Bergh:	direct—faint delayed positive, indirect—1:250,000, Mg. 0.4

The electrocardiogram showed no definite abnormality. Blood pressure 100/64.

Operation: January 22, 1935, eight days after admission (J. H. G.). Spinal anesthesia was employed, using 120 mg. of neocaine. An upper right rectus incision was made. Some difficulty was encountered in entering the peritoneal cavity because of rather extensive adhesions. The great omentum was adherent to the parietal peritoneum. The liver edge was obliterated by adhesions which anchored it to the costal margin. After combined blunt and sharp dissection, the stomach, duodenum, and colon were finally separated from the under surface of the liver. The latter structure was freed from the costal margin. The liver was slightly enlarged, normal in appearance, with a slightly rounded anterior edge. The gallbladder was small and shrunken and contained a few stones. Further exploration showed an unusual condition of the common and hepatic ducts. The duct system, which was easily brought to view through its entire extent, was found to be enormously dilated. The common duct was fully two inches in diameter. Each hepatic duct measured about one inch in diameter. The entire common duct down to the ampulla of Vater and both hepatic ducts as far as their tertiary divisions were

filled with biliary calculi. A vertical incision was made in the common duct about two inches above the duodenum and through which 48 calculi of various sizes and shapes were removed. The duct system was irrigated. A free flow of yellow bile followed the removal of the calculi. A subserous cholecystectomy was performed. The liver bed was sewn over. A No. 22 French catheter was placed in the common duct and the remainder of the incision in the duct sutured snugly around the tube. Two cigarette drains were placed down to Morrison's pouch and the wound closed in layers. Time of operation: One hour and five minutes.

Postoperative Course: There was no variation in the blood pressure postoperatively.



FIG. 1.—Roentgenogram (lateral view) made after the injection of lipiodol through the choledochostomy showing the enormous dilatation of the bile ducts.

First Postoperative Day: Hemoglobin, 93 per cent. Temperature, 101.2° F. Patient comfortable. No distention. Profuse drainage of bile through common duct tube.

Second Postoperative Day: Urine negative for bile and urobilin. Icteric index, 20. van den Bergh: direct—prompt positive. Indirect—1:100,000 Mg. I.O.

Third Postoperative Day: Urine negative for bile. Urobilin 1:10. Roentgenologic examination was made after injection of lipiodol into the common duct drainage tube. This showed the biliary radicals to be irregularly outlined. There was marked dilatation of the hepatic and common ducts (Fig. 1). No evidence of obstruction and nothing to suggest the presence of stones. Temperature 101.8° F. Wound clean. No cough or chest pain. Abdomen soft. Condition excellent.

Fourth Postoperative Day: Roentgenologic examination 24 hours after the lipiodol injection showed a small amount of opaque material still present in the biliary system. The common duct was completely empty.

Fifth Postoperative Day: It was noted that the patient presented marked asthenia. Had drained about 15 ounces of bile daily since operation. The asthenia was thought to be due to long standing chronic prandemic and intermittent biliary obstruction plus the recent loss of bile and pancreatic ferments through the common duct tube. For this reason the refeeding of the drained bile was instituted. This was continued until two days before death. The wound appeared clean. Blood count: white blood cells, 14,650; polymorphonuclear leukocytes, 72 per cent; lymphocytes, 10 per cent; monocytes, 16 per cent; eosinophiles, 1 per cent; basophiles, 1 per cent.

Sixth Postoperative Day: Temperature, 100.4° F. Wound edges reddened and puffed. The skin sutures were removed and about one ounce of thick sanguinopurulent material was evacuated from the upper and lower angles. A smear of this material showed a moderate amount of pus cells and debris, but no organisms. The culture, however, revealed *B. coli*, enterococcus and *Staphylococcus albus*. The chest was clear; the abdomen was soft and not distended. Marked asthenia persisted. Bile was being refeed by mouth. Hemoglobin, 75 per cent; blood pressure, 100/72. Patient was given a transfusion of 500 cc. by the citrate method.

Seventh Postoperative Day: Hemoglobin, 90 per cent; white blood cells, 15,900; 90 per cent polymorphonuclear leukocytes; lymphocytes, 4 per cent; monocytes, 6 per cent. Urine, bile negative; urobilin 1:5.

Eighth Postoperative Day: Patient appeared profoundly asthenic. Eyes sunken, conjunctivae injected, voice subdued and monotonous, and reaction to stimuli sluggish; beginning to ooze blood from the wound. There was no icterus. The clinical condition was ascribed to either hepatic or pancreatic insufficiency. However, because of apparent tenderness on pressure over the right lower chest near the axillary region, the possibility of a subphrenic infection or an abscess of the liver was considered. Consequently, aspiration was performed. Liver blood was obtained, which was negative upon culture. Because of the oozing of blood from the wound, the packing was removed to facilitate investigation. The wound surfaces were found separated down to the peritoneum with hemorrhage coming from several small vessels and oozing from the entire wound surface. The vessels were ligated and the wound was packed. Urine was negative for sugar, acetone and bile. Blood calcium 9.7 mg. per 100 cc. Hemoglobin 72 per cent. Patient given 500 cc. of blood by the citrate method. Blood urea nitrogen 69 mg. per 100 cc.

Ninth Postoperative Day: Blood urea nitrogen rose to 105 mg. per 100 cc. Urine, cloudy, acid, sp. gr., 1018, albumin 2 plus, sugar and bile negative, urobilin present in 1:5 dilution. Hemoglobin 88 per cent, white blood cells 28,000; 88 per cent polymorphonuclear neutrophils, and 8 per cent lymphocytes. General condition seemed slightly improved.

Tenth Postoperative Day: Urine, cloudy, acid, sp. gr., 1010; albumin 1 plus. Microscopic examination showed a few white blood cells, very few red blood cells, and epithelial cells. Culture of urine revealed *B. coli* and the enterococcus. The biliary drainage which was still profuse, was slightly positive for diastase and trypsin. Blood chemistry determinations were as follows:

Cholesterol:	200	mg. per 100 cc.
Cholesterol ester:	105	mg. per 100 cc.
Total protein:	6.4	%
Albumin:	3.9	%
Globulin:	2.5	%
Carbon dioxide:	44	volumes per cent
Urea nitrogen:	76	mg. per 100 cc.
Sugar:	195	mg. per 100 cc.
Chlorides:	535	mg. per 100 cc.
Uric acid:	4.0	mg. per 100 cc.
Creatinine:	3.5	mg. per 100 cc.
Icteric index:	17	
	87	

Eleventh Postoperative Day: Patient's condition became grave. Seemed stuporous and could be aroused only with great difficulty. Pulse weak and rapid. Blood pressure 90/60. The course was progressively down hill. Several foci of local infection were now present: (1) The wound; (2) a gangrenous patch on the anterior wall of the vagina; (3) a right parotitis. Blood culture, negative. Hemoglobin, 88 per cent; red blood cells, 4,810,000, platelets 240,000; white blood cells, 38,700; polymorphonuclear neutrophils, 85 per cent, of which there were 15 per cent with segmented nuclei and 70 per cent non-segmented; lymphocytes, 6 per cent; monocytes, 9 per cent; reticulocytes, 0.5 per cent. Blood volume studies:

Relative cell volume:	38%
Serum volume:	3,500 cc.
Cell volume:	2,140 cc.
Total blood volume:	5,640 cc.
Blood volume per kilo:	85 cc.

She had been receiving liver extract intramuscularly, two cubic centimeters twice daily.

Twelfth Postoperative Day: Urine, sp. gr., 1012, albumin 2 plus, bile negative, urobilin 1:20, occasional erythrocytes and clumps of leukocytes seen microscopically. Blood urea 90 mg. per 100 cc., cholesterol 180 mg., serum calcium 9.6 mg., chlorides 510 mg. Stool examination, tan color, urobilin present. Guaiac test positive for occult blood. Icteric index 30. A note by the medical consultant read: "From the history and the operative findings, there is every reason to believe that this patient had a very badly damaged liver parenchyma before operation. I believe that the postoperative asthenia is probably due largely to liver insufficiency, perhaps combined with pancreatic insufficiency, and that the nitrogen retention is the result of the prolonged low blood pressure. The blood pressure at the time of examination was 74/46, just barely sufficient to maintain a minimal amount of kidney function."

Thirteenth Postoperative Day: Blood chemistry:

Urea nitrogen:	114	mg. per 100 cc.
Creatinine:	3	mg. per 100 cc.
Cholesterol:	160	mg. per 100 cc.
Calcium:	8.7	mg. per 100 cc.
Phosphorus:	3.9	mg. per 100 cc.
Chlorides:	575	mg. per 100 cc.
Carbon dioxide:	34.5	volumes per cent
Total protein:	5.6%	
Albumin:	3.4%	
Globulin:	2.2%	
Icteric index:	30	
van den Bergh:	direct—Prompt positive, indirect—1:60,000,	mg. 1.5

Oozing from the wound continued from the eighth postoperative day. Tonight patient had a profuse epistaxis. Pulse gradually became weaker and the patient died with a terminal temperature of 107.4° F. (Table I.)

Postmortem Examination: The body was that of a pale, well-developed, well-nourished female of 54. The skin was light yellow, but the sclerae were not icteric. An incision into the subcutaneous tissues in the left upper margin of the wound disclosed white turbid fluid exuding from the fat. The peritoneum was everywhere smooth and glistening. There was no free fluid in the abdominal cavity. Several small areas of bronchopneumonia were present in the left lower lobe. There was a small blackish-red ulcer on the anterior vaginal wall just inside the labia minora. The stomach was dilated and filled with a large amount of bloody fluid. The gastric mucosa was pink and congested. On the anterior

THE HEPATO-RENAL SYNDROME

TABLE I

SUMMARY OF THE POSTOPERATIVE TEMPERATURE, PULSE, BILIARY DRAINAGE, FLUID INTAKE AND URINARY OUTPUT

Date	Pulse	Temperature	Urinary Output	Biliary Drainage	Fluid Intake By Mouth	Intravenous
Jan. 22 (oper.)	88	100° F.		12 ounces	54 ounces	
Jan. 23 (1st p.o. day)	100	102° F.	33 ounces	10 "	65 "	
Jan. 24	110	101° F.	57 "	10 "	72 "	
Jan. 25	100	101.6° F.	65 "	10 "	58 "	
Jan. 26	100	101° F.	38 "	7 "	80 "	
Jan. 27	100	100.8° F.	48 "	10 "	74 "	
Jan. 28	112	100.4° F.	30 "	5 "	42 "	
Jan. 29	104	100.2° F.	22 "	4 "	40 "	
Jan. 30	122	102.8° F.	Incontinent	3 "	Nothing	10 ounces
Jan. 31	130	Chill 106.8° F.	"	10 ounces	p.o. 38 "	25 "
Feb. 1	126	101.2° to 104.2° F.	"	Profuse	40 "	96 "
Feb. 2	120	104° F.	14 ounces	?	4 "	71.5 "
Feb. 3	120	104° F.	18 "	?		58.3 "
Feb. 4	120-160	Died 107.4° F.		?		

wall near the lesser curvature was a small superficial erosion 0.5 cm. long. There were also many tiny homogeneous red areas. The duodenum, small intestine, colon and rectum were congested and filled with bloody contents. The pancreas was moderately fatty. The pancreatic duct was slightly dilated and opened into the common duct 1 Mm. above the papilla of Vater.

The liver weighed 2,165 Gm. The anterior and superior surfaces were adherent to the diaphragm. The capsule was covered by fibrous adhesions. The organ was firm and its inferior edge was sharp. On section, the surface was pale and grayish-green. The lobular structure could be identified. The bile ducts in the larger portal fields were thickened and contained turbid yellow-brown bile. On the anterior surface of the liver in the region of the gallbladder fossa there was a white cylindrical prominence, which, on section, was found to be a thick-walled channel filled with turbid milky fluid. This channel was found to communicate with the bile ducts. The gallbladder fossa was clean. In the floor of the walled-off drainage tract a longitudinal opening into the common duct was present. The common bile duct was distended to 2 cm. in diameter and contained a small amount of bloody mucus. The mucosa was thickened and red. The duct opened into the duodenum by a patent orifice. The common bile duct, traced upward, was distended throughout and became continuous with the two distended, thickened, congested hepatic ducts. The intrahepatic bile ducts were dilated throughout. There were no stones in any of the biliary ducts.

The kidneys weighed 360 Gm. together. They were of equal size and flabby. The capsules stripped with ease, leaving a smooth grayish-yellow surface. The cut surface presented a somewhat widened cortex which was jaundiced. The markings within it were fairly well delineated. The corticomedullary demarcation was sharp. The pelves were congested. The ureters were narrow and pale. The renal arteries and veins were smooth and clear.

Microscopic Examination.—*Kidneys:* The capsule was thin. The general architecture of the kidney appeared unchanged. The convoluted tubules of the cortex were, in general,

of normal size and width. In some areas, they were closely approximated; in other places, however, they appeared separated by a widening of the intertubular stroma which was spongy and frequently infiltrated with lymphocytes, occasional polymorphonuclear leukocytes and rare plasma cells. The intertubular capillaries, for the most part, contained few red blood cells; in places, however, they were congested. The walls of the interlobular arteries were normal. The afferent arterioles occasionally showed slight hyalinization. The lumen of the convoluted tubules frequently contained granular masses, occasionally desquamated epithelial cells. The epithelial lining of the convoluted tubules did not show striking changes. However, on close examination, one quite frequently found the epithelial cells vacuolated, with occasional loss of nuclei. Some of them contained yellowish-brown material, which was apparently bile pigment. Some of the tubules presented a flattened epithelium, and such tubules contained a few polymorphonuclear leukocytes. Only rarely were tubules found where the epithelium showed more severe degenerative changes, such as hyaline droplet degeneration.

The majority of the glomeruli were well preserved; only a very few were fibrotic.

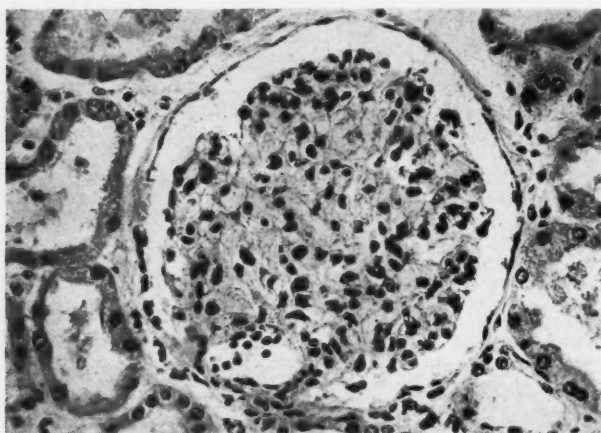


FIG. 2.—Photomicrograph of section from the kidney. The glomerulus is enlarged, and the intercapillary stroma is prominent and spongy as if distended with fluid.

In the vicinity of such fibrotic glomeruli the tubules were atrophic, the stroma increased and infiltrated with lymphocytes. Most of the glomeruli were strikingly large. Their capsules were not thickened; the parietal epithelial cells were flattened; in general, Bowman's space was empty. In spite of the striking size of the malpighian corpuscles, there was no increase in their cellularity. The covering epithelial cells of the tufts were not enlarged, neither were the endothelial cells unduly prominent. The capillaries contained a normal amount of red blood cells and only occasional leukocytes. The intercapillary connective tissue framework (Zimmermann⁴²) was prominent and it appeared spongy, as if distended by fluid (Fig. 2).

The medulla of the kidney showed frequent nests of lymphocytes, plasma cells and infrequent polymorphonuclear leukocytes within the stroma. The Henle's loops contained inspissated homogeneous material and occasional leukocytes. Bile stained casts were seen and occasional granular and hyaline cylinders. Very infrequently, round calcified masses were noted enclosed within the lumen. In one area where the medulla bordered on the peripelvic connective tissue and fat tissue there was a hemorrhage, and some of the adjacent tubules contained blood. One section showed a large hemorrhage beneath the pelvic epithelium extending into the peripelvic fat tissue. Around this hemorrhage there was considerable infiltration with polymorphonuclear leukocytes.

Liver: The capsule was thin. The lobular structure was distinct and intact. The

THE HEPATO-RENAL SYNDROME

periportal connective tissue seemed markedly increased. The central veins contained but little blood. The liver cells about the central veins appeared somewhat shrunken and contained some yellowish-brown granular pigment. The sinus walls and Kupffer cells were separated from the liver cords, forming appreciable Disse spaces. The latter contained much granular debris, rarely a red blood cell. In places, large amounts of bile pigment were contained within vacuolated, swollen, or shrunken liver cells, surrounded or compressed by fibrous tissue from the portal fields. The latter were much enlarged by fibrous tissue and infiltration with inflammatory cells consisting mainly of lymphocytes, some plasma cells and polymorphonuclear leukocytes (Fig. 3). The bile ducts within the portal fields were increased in number. In some of the bile ducts there were polymorphonuclear leukocytes between the epithelial cells. The portal veins and hepatic artery presented no changes. A section of a large bile duct slightly removed from the region of the hilus showed an edematous wall and infiltration by numerous polymorphonuclear leukocytes, eosinophiles, active phagocytes, and fibroblasts. There was hemorrhage into some of the

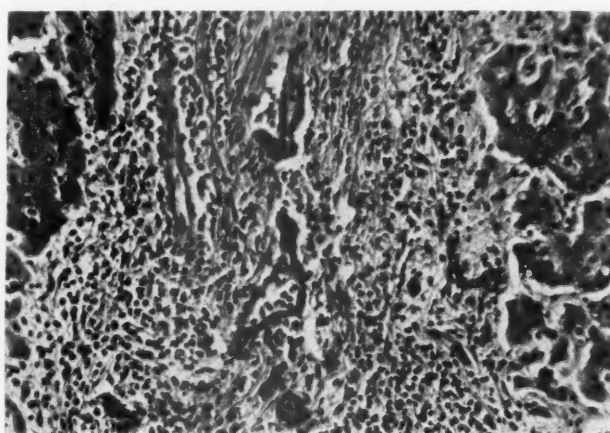


FIG. 3.—Photomicrograph of section from the liver showing acute and chronic cholangitis.

liver cords abutting upon this duct and some hemorrhage into the wall of the duct. There was much bile pigment in the cells about the portal fields. Throughout the sections, there was no evidence of liver cell necrosis.

SUMMARY: The liver showed the pathologic picture of an acute and chronic cholangitis and cholangiolitis with icterus. There was no evidence of severe parenchymal damage.

The kidneys showed focal interstitial inflammation and edema. There was, however, no evidence of severe degenerative change in the tubular epithelium, but there was a striking glomerular lesion.

Anatomic Diagnosis: Acute and chronic cholangitis. Acute intercapillary glomerulonephritis (MacCallum³²). Jaundice (slight). Gastric erosions. Vaginal ulcer. Bronchopneumonia, left lower lobe. Pulmonary edema and congestion. Mild parenchymatous degeneration of the liver, heart and kidneys. Acute congestion of the spleen. Fibrous pleural adhesions.

Discussion: Concerning the cases in Group I of Heyd's classification, namely, those characterized by hyperpyrexia and death within 48 hours of operation, considerable disagreement and controversy already exist. Thus,

Touroff,³⁸ in a recent communication, is rightfully cautious against entertaining a diagnosis of "liver shock," unless there has been a corroborative complete postmortem examination. He reviewed a series of cases from the Mt. Sinai Hospital that were subjected to simple cholecystectomy with drainage. The patients were neither jaundiced nor acutely ill at the time of the operation and had not been subjected to any previous operative procedure on the biliary tract. Without apparent cause, they developed the classic picture of rapidly rising temperature, shock and early death. In a number of instances, the clinical diagnosis of "liver shock" was entertained, yet careful postmortem examination revealed a previously unrecognized intra-abdominal or pulmonary infection to explain the whole picture.

On the other hand, the experiences of the senior author (J. H. G.) 12 or 13 years ago at the old New York Hospital came to mind and those records were recently reviewed in order to corroborate the impression gained at that time. On the Second Surgical Division, in those days, many cases of acute cholecystitis were treated as emergencies, as is being advocated by a number of surgeons at the present time. A group of the patients so treated developed the typical picture under discussion and died within 48 hours with hyperpyrexia as the outstanding symptom. Yet, careful postmortem examination, in two instances, failed to reveal the cause of death. There was not the slightest evidence of infection and the liver sections showed only occasional periportal accumulations of polymorphonuclear leukocytes. These cases were disconcertingly puzzling at the time and the thought was entertained that a profound physiologic or chemical change had taken place which could not be determined by any known clinical or laboratory methods. Since then, as far as we know, nothing of any importance has developed to throw light on this obscure picture.

The various clinical and pathologic aspects of the so-called "hepato-renal" syndrome, as reported in the literature, deserve careful consideration, in the light of the case reported herewith. Many of the reported instances of "hepato-renal" syndrome are based on clinical grounds only and lack corroborative autopsy findings. Those reports that include postmortem examinations present a curious lack of uniformity of the pathologic picture. Certainly, the degree and extent of the degenerative changes encountered in the liver and kidneys vary considerably. Why should one patient present minimal postmortem findings while another, with the identical clinical picture, exhibits extensive degenerative changes? This considerable variation in the degree and extent of the pathologic findings suggests to us a possible explanation. It seems possible that many of these patients have some degree of kidney damage before the surgical attack on the biliary system and that their margin of safety from the standpoint of kidney reserve is indeed small. This impairment may not be apparent before operation or may not be demonstrable by any known laboratory methods. Following the procedure on the diseased biliary tract, with its associated surgical trauma and the greatly altered physiology that must necessarily follow, the already impaired kidneys are unable to cope with the

additional load thrown upon them and soon break down completely. Certainly, the clinical picture with the relatively free interval of five to ten days after operation is suggestive confirmation of this thought. It must not be forgotten, too, that the same syndrome has been known to follow operations upon the gastro-intestinal tract and also, after extensive cutaneous burns, conditions known to be closely linked with disturbances of protein metabolism.

There is another group of patients who develop the typical so-called "hepato-renal" syndrome and, yet, the findings at autopsy are minimal and offer no anatomic explanation of the cause of death. Doctor Klemperer, pathologist at Mt. Sinai Hospital, has given the case herewith reported considerable study and thought, and he feels very definitely that the slight parenchymatous degeneration of the liver and kidneys found at necropsy is insufficient to explain the cause of death. Certainly, the liver sections aside from the cholangitis show nothing of great moment, and the reason for the hemorrhages from the mucous membrane surfaces cannot be demonstrated. In reviewing the sections of the kidneys, however, one is impressed by the peculiar appearance of the glomeruli. Most of them are strikingly large without any cellular increase. The intercapillary connective tissue framework (Zimmermann) is prominent and appears spongy, as if distended by fluid (Fig. 2). The term "serous glomerulitis" is suggested to describe this feature. A similar finding has been described by W. G. MacCallum.³² In reviewing the kidney sections of hundreds of cases showing glomerular changes in a series of about 5,000 autopsies, he noted a peculiar exudation into the glomeruli of patients dying of an acute illness, which resulted in toxic injury to the kidneys. The most striking feature was the distension of the lobules of the glomeruli into a club shape by an exudate which separated the capillaries from one another and from the overlying basement membrane. The latter structure was stretched and smooth and widely separated from the underlying capillaries. His illustration of this condition strongly resembles that presented by the kidneys in our case. In other cases, where the illness was of longer duration, the lobules were adherent and covered over by a smooth basement membrane, while the capillaries were separated by definitely stainable connective tissue. He concluded that the first picture might very well be interpreted as the initial stage of glomerular injury which goes on, with continuation of the disease process, to the chronic form known to clinicians as glomerulonephritis.

After a critical review of the literature and a careful study of the case reported herewith, we have formed the opinion that no logical or satisfactory explanation of the syndromes originally described by Heyd has as yet been offered. Although thought by many authors to follow surgery of the biliary tract only, these clinical pictures have appeared also in cases of intestinal obstruction, cutaneous burns, *etc.* The lack of uniformity of anatomic changes to explain the cause of death is noteworthy, as is also the variation in the extent of the degenerative changes. We believe that the syndromes under discussion are dependent upon profound chemical changes which we are

unable to definitely determine by the clinical and laboratory methods available at the present time.

REFERENCES

- ¹ Bartlett, W., Jr.: Renal Complications of Biliary Tract Infections. *Surg., Gynec., and Obstet.*, **56**, 1080, 1933.
- ² Behrend, M.: *Surgical Diseases of the Gall Bladder, Liver, Pancreas, and Their Treatment*. Phila., F. A. Davis Co., 213, 1927.
- ³ Boyce, F. F.: An Experimental Study of the So-called Liver Death Syndrome in Biliary Surgery. *Proc. Soc. Exper. Biol. and Med.*, **32**, 479, December, 1934.
- ⁴ Boyce, F. F., and McFetridge, E. M.: So-called "Liver Death"—A Clinical and Experimental Study. *Arch. Surg.*, **31**, 105, July, 1935.
- ⁵ Boyce, F. F., and McFetridge, E. M.: "Liver Deaths" in Surgery. *New Orleans Med. and Surg. Jour.*, **88**, 563, March, 1936.
- ⁶ Boyce, F. F., and McFetridge, E. M.: The So-called "Liver Death." *Arch. Surg.*, **32**, 1080, June, 1936.
- ⁷ Boyce, F. F., Veal, J. R., and McFetridge, E. M.: An Analysis of the Mortality of Gall Bladder Surgery. *Surg., Gynec. and Obstet.*, **63**, 43, July, 1936.
- ⁸ Cave, Henry W.: Dangers Incident to Cholecystectomy. *ANNALS OF SURGERY*, **84**, 371, September, 1926.
- ⁹ Cole, W. H.: The Role of Hepatic Insufficiency in Surgical Problems. *Jour. Missouri State Med. Assn.*, **30**, 351, September, 1933.
- ¹⁰ Colp, R., Doubilet, H., and Gerber, I. E.: The Relation of Cholecystitis to Pathologic Changes in the Liver. *ANNALS OF SURGERY*, **102**, 202, 1935.
- ¹¹ Connell, F. G.: Rapid-High Temperature Deaths Following Biliary Tract Surgery. *ANNALS OF SURGERY*, **94**, 363, September, 1931.
- ¹² Connell, F. G.: Liver Deaths (So-called)—Rapid High Temperature Deaths. *ANNALS OF SURGERY*, **100**, 319, 1934.
- ¹³ Eiss, S.: Conservation of Hepatic Function in Gall Bladder Operations. *ANNALS OF SURGERY*, **98**, 348, 1933.
- ¹⁴ Fitz-Hugh, T., Jr.: Hepato-Urologic Syndromes. *Med. Clinics N. Amer.*, **12**, 1101, January, 1929.
- ¹⁵ Graham, E. A.: Hepatitis: A Constant Accompaniment of Cholecystitis. *Surg., Gynec., and Obstet.*, **26**, 521, 1918.
- ¹⁶ Helwig, F. C., and Orr, T. G.: Traumatic Necrosis of the Liver with Extensive Retention of Creatinine and High Grade Nephrosis. *Arch. Surg.*, **24**, 136, 1932.
- ¹⁷ Helwig, F. C., and Schutz, C. B.: A Liver Kidney Syndrome—Clinical, Pathological, and Experimental Studies. *Surg., Gynec., and Obstet.*, **55**, 570, 1932.
- ¹⁸ Helwig, F. C.: A Review of the Recent Advances in the Knowledge of the Pathology of the Liver. *Am. Jour. Surg.*, **19**, 402, 1933.
- ¹⁹ Helwig, F. C., and Schutz, C. B.: A Further Contribution to the Liver Kidney Syndrome. *Jour. Lab. and Clin. Med.*, **21**, 264, 1935-1936.
- ²⁰ Heuer, G. J.: The Factors Leading to Death in Operations upon the Gall Bladder and Bile Ducts. *ANNALS OF SURGERY*, **99**, 881, June, 1934.
- ²¹ Hewitt, H. W.: Liver Deaths Following Surgery of the Gall Bladder. *Jour. Mich. Med. Soc.*, **34**, 421, July, 1935.
- ²² Heyd, C. G.: Hepatitis Associated with or Sequential to Inflammatory Diseases of the Abdomen. *L. I. Med. Jour.*, **17**, 17, 1923.
- ²³ Heyd, C. G., MacNeal, W. J., and Killian, J. A.: Hepatitis in Its Relation to Inflammatory Disease of the Abdomen: A Clinical and Laboratory Study. *Trans. Am. Assn. of Obstet., Gynec., & Abd. Surgeons*, **36**, 251, 1923.
- ²⁴ Heyd, C. G.: The Liver and Its Relation to Chronic Abdominal Infection. *ANNALS OF SURGERY*, **79**, 55, 1924.

- ²⁵ Heyd, C. G., MacNeal, W. J., and Killian, J. A.: Hepatitis and Its Relation to Inflammatory Disease of the Abdomen: A Clinical and Laboratory Study. *Am. Jour. Obstet. and Gynec.*, **7**, 413, 1924.
- ²⁶ Heyd, C. G.: "Liver Deaths" in Surgery of the Gall Bladder. *Tr. Sect. of Surg., Gen. and Abd., of the A.M.A.*, p. 144, 1931.
- ²⁷ Heyd, C. G.: "Liver Deaths" in Surgery of the Gall Bladder. *J.A.M.A.*, **97**, 1847, December, 1931.
- ²⁸ Heyd, C. G.: Liver Function and "Liver Deaths." *Surg., Gynec., and Obstet.*, **57**, 407, 1933.
- ²⁹ Heyd, C. G.: Significance of Liver Function from the Surgeon's Standpoint. *N. Y. State Jour. Med.*, **33**, 1317, November 15, 1933.
- ³⁰ Judd, E. S., Nickel, A. C., and Wellbrock, W. L. A.: The Association of the Liver in Disease of the Biliary Tract. *Surg., Gynec., and Obstet.*, **54**, 13, 1932.
- ³¹ Lieber, M. M., and Stewart, H. L.: Renal Changes Following Biliary Obstruction, Decompression and Operation on the Biliary Tract. *Arch. Path.*, **19**, 636, 1935.
- ³² MacCallum, W. G.: Glomerular Changes in Nephritis. *Bull. Johns Hopkins Hosp.*, **55**, 416, 1934.
- ³³ Riley, J. W.: Post-operative Complications of Biliary Tract Surgery: Their Prevention and Treatment. *Jour. Oklahoma State Med. Assn.*, **24**, 190, 1931.
- ³⁴ Schutz, C. B., Helwig, F. C., and Kuhn, H. P.: A Contribution to the Study of So-called Liver Death. *J.A.M.A.*, **99**, 633, August 20, 1932.
- ³⁵ Sharples, C. W.: Liver Deaths Following Operation of Biliary Tract. *West. Jour. Surg., Obstet., and Gynec.*, **42**, 337, 1934.
- ³⁶ Stanton, E. MacD.: Immediate Causes of Death Following Operations on Gall Bladder and Ducts. *Am. Jour. Surg.*, **8**, 1026, May, 1930.
- ³⁷ Sutton, J. E., Jr.: High Temperature Liver Death Syndrome. *Proc. Soc. Exper. Biol. and Med.*, **32**, 712, February, 1935.
- ³⁸ Touroff, A. S. W.: Unrecognized Post-operative Infection: A Cause of the Syndrome of So-called "Liver Shock." *Surg., Gynec., and Obstet.*, **62**, 941, June, 1936.
- ³⁹ Walters, W., and Parham, D.: Renal and Hepatic Insufficiency in Obstructive Jaundice. *Surg., Gynec., and Obstet.*, **35**, 605, 1922.
- ⁴⁰ Weiss, S.: Liver Deaths and Their Prevention. *Am. Jour. Surg., New Series*, **23**, 96, 1934.
- ⁴¹ Wilensky, A. O., and Colp, R.: Retention of Nitrogen Bodies of the Blood to Surgical Problems in Liver and in Biliary Tract Disease. *Arch. Path.*, **15**, 635, 1927.
- ⁴² Zimmermann, K. W.: Über den Bau des Glomerulus der menschlichen Niere. *Z. mikrosk.-anat. Forschg.*, **48**, 520, 1920.

TUMORS VENTRAL TO THE SACRUM

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THE region ventral to the sacrum and sacrococcygeal joint is the site of many complex fetal changes. While tumors arising in this region are rare—according to Ewing³ occurring only once in 34,582 tumors of the newborn, and according to statistics at The Mayo Clinic, for the period 1922–1936, occurring in only one out of approximately every 40,000 registrations—their incidence is such as to prompt consideration of their pathogenesis, diagnosis and treatment.

This study is based on a series of 22 cases of tumor ventral to the sacrum seen at The Mayo Clinic from 1922 to 1936, inclusive, in which the diagnosis was confirmed at operation. Hundling⁸ has previously reported 19 such cases which were encountered at the clinic prior to 1922, and Fletcher, Woltman and Adson⁵ have previously reported in detail the five cases of chordoma which are included in this report.

Located embryonically in the ventral sacrococcygeal region are the spinal cord, nerve tissue, postanal portion of the hindgut, neurenteric canal, caudal end of the notochord and the bony vertebral canal. The embryonic development² and subsequent disappearance of the structures in this region aid in explaining the origin of these tumors. The primitive streak lies posterior to the neural groove and arises, as does the neural groove, from the embryonic area. The notochord is formed by the proliferation of cells from the anterior end of the primitive streak. It is epithelial in origin. Early in its development the notochord is surrounded by secondary mesoderm. This, then, becomes the primitive vertebral column. As the vertebral bodies are formed, after the fourth week, the continuity of the notochord is broken. The notochord disappears in the region of the vertebral bodies, but persists in the region of the intervertebral fibrocartilages. After the fourth month the notochord has disappeared as a separate structure, but remnants are believed to persist as the nucleus pulposus of the intervertebral fibrocartilages. Linck and Warstat⁹ were of the opinion that rests of chordal cells exist outside the axial skeleton anlage, and these can be recognized in the sacrococcygeal region in the adult. These rests may lie either in the body of the sacral vertebrae or on their anterior or posterior aspects.

As the notochord is forming, the primitive groove appears on the surface of the primitive streak. The anterior end of the groove, which is embraced by the posterior portion of the neural fold, deepens and forms a canal between the neural groove and the ventral-lying entodermal vesicle, which is the primi-

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tive intestinal canal. This is called the "neurenteric canal" (Fig. 1), and it gradually moves to a position caudal to the proctodeum. The neurenteric canal is but a transitory passage and disappears in man before the neural groove closes to form the neural tube.

The postanal gut is formed by the union of the proctodeum and that portion of the hindgut proximal to the neurenteric canal. The proctodeum is a surface depression limited at its depth by the proctodeal membrane. The disappearance of this membrane completes the formation of the rectum and anus. The union of proctodeum and hindgut, however, does not take place at the distal end of the hindgut.^{2, 10} That portion of the hindgut distal to the union with the proctodeum is known as the "postanal gut," and it lies on the ventral

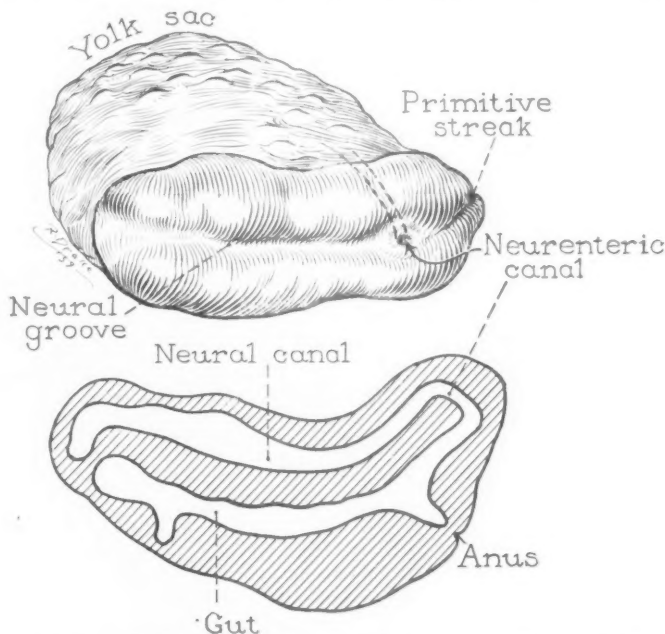


FIG. 1.—Dorsal view of a human embryo 1.54 Mm. long (modified after Graf Spee). Longitudinal (sagittal) section through an advanced embryo of Bombinator (modified after Goetta in Herturg, Oscar, and Mark, E. L.: Textbook of the Embryology of Man and Mammals, London, Swan, Sonnenschein and Co., 1892, p. 120, fig. 80).

surface of the coccyx (Fig. 2). This structure atrophies early. It is apparent, therefore, how these primitive structures, as they atrophy, may leave a nidus for further growth, with the formation of a tumor.

Tumors ventral to the sacrum have at times been popularly known as "Middeldorpf" tumors, but this term should be limited to those teratomatous tumors that arise from the postanal gut, as first clearly described by Middeldorpf.¹⁰ Tumors ventral to the sacrum may vary from those the size of an egg to large growths which fill the true pelvis and push the anus and genitalia forward. They may be rather superficial or be quite deeply placed within the hollow of the sacrum. The tumors are usually encapsulated and rarely invade the rectum but, as will be shown later, they may invade the bony sacrum or encroach on the intervertebral foramina and compress the nerve trunks.

The general symptoms produced vary greatly with the associated pathologic changes. In some cases there may be no symptoms; or an indefinite dull ache or pain in the lower part of the back or pelvis, which may occasionally be associated with constipation, may be the only complaint. In other cases serious nerve encroachment may produce weakness in the legs, sciatic pain, rectal or urinary incontinence, and areal numbness. In some cases draining perirectal sinuses from incised dermoids are seen. Consequently, digital examination of the rectum is the most valued single procedure in the diagnosis of tumors ventral to the sacrum, and this alone almost always will give the clue to the diagnosis. It is important, however, to examine thoroughly the hollow of the sacrum. If this is done, the true diagnosis is established and

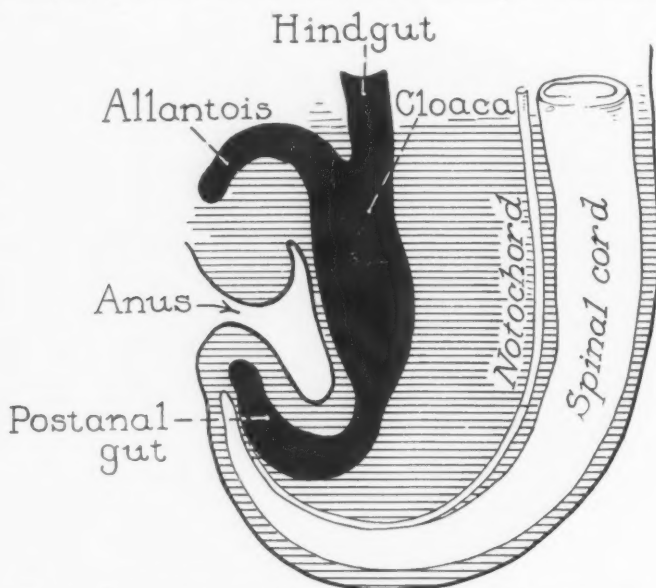


FIG. 2.—Reconstruction of the hindgut of an embryo 6.5 Mm. long (modified after Keibel).

the patient may be saved needless hemorrhoidectomy, prostatic massage, arthritic treatment, or even laminectomy, for relief of his symptoms.

Conditions to be considered in the differential diagnosis, suggested by this series of cases, include: Cord tumor, tumor of the cauda equina, anterior spina bifida with meningocele, primary sarcoma of the sacrum, pelvic tumors such as ovarian cysts, fibromyomata or adenomyomata, masses of metastatic lymph nodes, rectal fistulae and perirectal abscesses.

The treatment of choice is surgical removal, utilizing the posterior approach through a modified Kraske incision. Radium and roentgen therapy are advised when removal is incomplete, since prolongation of life and relief of symptoms can frequently be obtained by these measures (Table I).

CHORDOMATA.—The term "chordoma" was first used by Ribbert, in 1894, and the first sacrococcygeal chordoma was described by Feldmann,⁴ in 1910. The term is now used to describe tumors whose cellular structure has the characteristic appearance microscopically of the notochord. There are approximately 125 cases of chordoma on record.¹²

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TABLE I
TUMORS VENTRAL TO SACRUM

Diagnosis	No. of Cases	Sex		Age Range	Predominant Symptoms	No. of Cases Reveal- ing Mass Rectally	Prognosis
		M.	F.				
Chordoma . . .	8	5	3	14 to 65	Pain in lower part of spine; nerve involvement;* constipation	8	Poor
Dermoid cyst.	9		9	1½ to 48	Dull pelvic pain; draining sinus; mass at birth	7†	Good
Teratoma . . .	1		1	7	Perineal mass at birth	‡	Good
Fibrosarcoma.	1	1		51	Pain in rectum; nerve involvement	1	Poor
Chondromyxosarcoma	1	1		73	Mass; loss of weight; constipation	1	Poor
Squamous cell epithelioma	1	1		53	Sciatic pain	1	Poor
Fibroma	1		1	29	Sacral pain	1	Good
Total	22	8	14	3 mos. to 73 yrs.		19	

* Sensory disturbance noted in three cases.

Numbness, rectal or urinary incontinence.

† No record of rectal examination in the cases of two infants.

‡ No record of rectal examination.

Chordomata arising from the remnant of the notochord may, as stated previously, have as their origin the nucleus pulposus or the rests of chordal cells outside the axial skeleton. However, since chordomata occur with about equal frequency in the sacrococcygeal and dorsum sellae regions, and since one has not been reported in the thoracic region, it seems more plausible to many that their origin is in the chordal cell rests outside the axial skeleton anlage. Anatomically the tumors seem to arise in relation to the vertebral body rather than the nucleus pulposus.

Sacrococcygeal chordomata may arise within the vertebral body and project either ventrally or dorsally, or both; or they may arise ventral or dorsal to the sacrum. It is only in those arising or projecting ventrally, however, that we are interested. These tumors may grow to a large size, are usually encapsulated, may invade intervertebral foramina and cause pressure on nerve structures, and may cause marked bony destruction; they rarely if ever, however, involve the rectum. Metastasis is rarely seen, although the incidence of recurrence is quite high, being given by Stewart¹² as 86.5 per cent. Recurrent lesions are local and recurrence is usually due to incomplete removal of the original growth. Grossly these tumors are gelatinous, lobulated and usually quite friable; microscopically, certain criteria have been established

on which to base the diagnosis. Fletcher, Woltman, and Adson,⁵ for example, have based the diagnosis on: "(a) The formation of intracellular and extracellular mucus; (b) the presence of physaliphorous or vacuolated mucus containing cells; (c) the lobulated arrangement of the tumor cells, which usually grow in cords; (d) the occasional occurrence of vacuolation of the nuclei; and (e) the close resemblance to notochordal tissue as seen in the nuclei pulposi of the intervertebral disks."

The last five cases in this group of cases of chordoma have been previously reported in detail by Fletcher, Woltman and Adson. They will be reviewed briefly here only to complete the series:

Case 1.—A girl, age five years, was brought to the clinic August 6, 1930. She had had increasing constipation for two and one-half years, and obstipation had been present for ten days. Rectal examination revealed a mass posterior to the rectum, pushing it anteriorly against the pubis. This mass measured 8x6x4 cm. and nearly filled the pelvis. Roentgenograms of the pelvis were negative. The mass was removed, as completely as possible, August 15, 1930. It extended from the ventral sacrum back around the coccyx and out into the right buttock. Radium was applied following operation. Five months later the bowels were regular and the patient was doing nicely. The microscopic report was chordoma.

Case 2.—A girl, age three months, was brought to the clinic March 11, 1935. In the previous three weeks her right hip had appeared larger. Constipation had also been present for three weeks. Examination revealed a firm mass in the right buttock. Rectally the mass was felt on the right, 6 cm. in diameter, pushing the rectum to the left. Roentgenograms of the pelvis were negative. The mass was incompletely removed March 13, 1935. It was very friable, vascular, and was invading the right gluteal muscles. The patient returned home and later died. The microscopic report was chordoma.

Case 3.—A man, age 39, registered at the clinic June 25, 1936. He had had pain in the lower part of his back and at the end of his spine for the previous five months. This pain was worse at night. During the same period an increasing constipation was noted. Rectal examination revealed a firm, smooth rounded mass, 7x5 cm., posterior to the rectum and attached to the sacrum. It was not tender. The lumen of the rectum was partially obstructed. Roentgenograms revealed destruction of the lower half of the sacrum. The tumor was removed as completely as possible July 7, 1936. It was encapsulated. Roentgen therapy was instituted following operation. On discharge the patient was free of symptoms and only some roughness of the sacrococcygeal area persisted. The microscopic report was chordoma (Fig. 3).

Case 4.—A woman, age 65, registered at the clinic September 4, 1923. She had had a severe, sharp pain at the end of her spine for five years. Hemorrhoidectomy and injection of the peri-anal nerves with alcohol, in 1920, had given no relief. There was sciatic projection of this pain, and rectal incontinence and some loss of vesical control was also noted. Rectal examination revealed a relaxed anal sphincter and a mass ventral to the sacrum. Sensory impairment of the fourth and fifth sacral nerves was found. Roentgenograms revealed destruction of the upper portion of the sacrum. On October 6, 1923, the tumor, which had invaded the sacrum, was incompletely removed and radium was applied. The patient died two years later. The microscopic report was chordoma.

Case 5.—A man, age 58, registered at the clinic January 26, 1925. He had had progressive tenderness and pain at the end of his spine for three months. Rectal examination revealed a hard round mass, 4 cm. in diameter, posterior to the rectum. It was not tender. Roentgenograms revealed necrosis of bone in the sacrum. The tumor was removed as thoroughly as possible January 30. Radiotherapy was then instituted. Nine years later the patient felt well. The microscopic report was chordoma.

Case 6.—A man, age 47, registered at the clinic for the second time April 6, 1925, with the complaint of pain and numbness in the region of his rectum and coccyx of 18

TUMORS VENTRAL TO THE SACRUM

months' duration. He had also had progressive trouble with his bladder for one month. Rectal examination revealed a relaxed anal sphincter associated with anesthesia. A firm, smooth, fixed mass, 7 cm. in diameter, was palpated ventral to the sacrum, and roentgenograms revealed destruction of the lower two-thirds of the sacrum. On May 9, 1925, incomplete removal of the mass was accomplished. It was friable and resembled a colloid tumor. Roentgen therapy was administered. In 1929 a recurrent growth was partially removed. The patient died five years after the onset of his symptoms. The microscopic report was chordoma.

Case 7.—A man, age 61, registered at the clinic December 9, 1927. He had had progressive pain in his right hip associated with sensory disturbance for eight months. Urinary incontinence had been present for three weeks. Rectal examination revealed a relaxed sphincter and a firm mass filling the pelvis, apparently arising from the ventral aspect of the sacrum. Roentgenograms revealed some destruction of the sacrum.

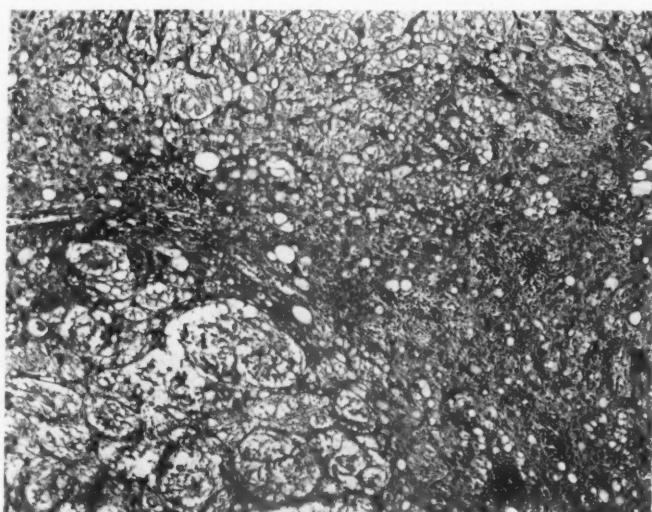


FIG. 3.—(Case 3). Photomicrograph of chordoma.

Biopsy only was attempted and radiotherapy was advised. The microscopic report was chordoma.

Case 8.—A man, age 26, first registered at the clinic August 19, 1930. He had had pain at the end of his spine, which was projected to the genitalia and inner thigh, and increasing constipation for one year. Rectal examination revealed a fixed tumor, 7.5 cm. in diameter, ventral to the sacrum. He was operated upon, elsewhere, and was given radium treatment. He returned to the clinic January 7, 1932, complaining of severe pain. Examination at this time revealed urinary and rectal incontinence and a mass ventral to the sacrum. Roentgenograms revealed cystic degeneration of the right half of the sacrum. The mass was removed as completely as possible January 14, 1932. On discharge the patient was free of pain and the function of his bladder had improved. The microscopic report was chordoma.

Five of these eight patients were males and three females. In only two cases was there any suggestive history of previous trauma. The ages ranged throughout the life span, two of the patients being children. Sacrococcygeal chordomata are quite rare in children.

Pain was the initial symptom in the case of each adult patient. This pain was usually localized in the back at the lower end of the spine. Sciatic projection was frequent. Later, sensory disturbances frequently appeared,

as did urinary and rectal incontinence. Involvement of nerves depended on encroachment of the tumor on the sacral nerve plexus and trunks. Constipation was frequently noted. Roentgenograms revealed some bony destruction of the sacrum in five of the cases. The duration of symptoms varied from three weeks to five years, the average being 17 months. Rectal examination revealed a mass in each case, and was the most valuable single finding in the examination. The mass was firm, usually smooth, fixed to the sacrum, and was not tender.

The diagnosis can be made positively only after microscopic examination. However, the presence of a firm, smooth, fixed and nontender mass ventral to the sacrum, associated with pain in the sacral region, later with sensory disturbances and usually with rectal and urinary incontinence, is quite suggestive of sacrococcygeal chordoma. The conditions which most frequently have to be considered in the differential diagnosis of sacrococcygeal chordoma are: Tumor of the cauda equina, meningocele, and sarcoma or enchondroma of the sacrum.

Surgical removal of the tumor as completely as possible offers the best chance for cure. The Kraske type of incision posterior to the rectum, with removal of the coccyx, probably gives the most satisfactory approach to these tumors; however, the dorsal approach, unroofing the tumor and removing it intrasacally, may be a better approach when marked involvement of the sacrum is present. Because of its ramifications, complete removal of the tumor is sometimes very difficult.

The prognosis in this group of cases is quite poor and the percentage of local recurrence is extremely high. However, surgical removal followed by extensive irradiation does prolong life, relieve pain and often gives a long period of freedom from symptoms. Chesky¹ reported the average length of life after operation to be six and one-half years.

DERMOID CYSTS.—Dermoid cysts are ectodermal in origin and are lined with epithelium which is constantly secreting and desquamating. Such cysts are filled with sebaceous material and may contain ectodermal derivatives. These cysts occur where ectodermal structure is not found under normal conditions. It is generally agreed that such cysts originate by inclusion of a portion of ectoderm during faulty coalescence of cutaneous surfaces in embryonic life. They occur along the course of ectodermal invaginations. Those presenting as tumors ventral to the sacrum may arise from the proctodeal membrane or from coccygeal vestiges. Galletly⁶ was of the opinion that they may also arise from the neurenteric canal, which is an ectodermal invagination.

Dermoid cysts may be located close to the sacrococcygeal region or be quite deeply situated in the hollow of the sacrum. If large, they may bulge into the perineum and push the genitalia forward or they may encroach on the rectal lumen. These cysts are encapsulated, have little or no blood supply of consequence, never invade the rectum, but if large may infrequently cause erosion of the sacrum and injury to nerve trunks. They are not fixed primarily.

ABBREVIATED REPORT OF NINE CASES OF DERMOID CYSTS

Case 1.—A woman, age 30, registered at the clinic November 15, 1922. She had undergone an operation for a perirectal "abscess" elsewhere, and a draining perirectal sinus had persisted. She had also been subjected to three operations for fistula-in-ano. Rectal examination at the clinic revealed a definite thickening on the posterior rectal wall 7.5 cm. above the anal margin. On August 31, 1923, the sinus tract was dissected out, and it was found to lead to a small cyst anterior to the sacrococcygeal joint. The pathologic diagnosis was dermoid cyst containing hair.

Case 2.—A woman, age 23, registered at the clinic June 2, 1925. She had had urinary difficulty for six months and partial rectal incontinence for five months. Rectal examination revealed a firm mass ventral to the sacrum which pushed the rectum to the right and displaced the pelvic organs upward. Roentgenograms of the pelvis were negative. On June 8, 1925, a large mass, 10 cm. in diameter, which was buried in the hollow of the sacrum, was completely removed. Complete relief of symptoms followed. The pathologic diagnosis was dermoid cyst containing only fat.

Case 3.—A girl, age four months, was brought to the clinic August 9, 1926. A tumor over her right buttock had been noticed at birth. It had recently become more prominent. Examination revealed a soft tumor with firm nodules extending up to the sacrum, and roentgenograms revealed a soft tissue shadow below the pelvis on the right. On August 14, 1926, a mass 10 cm. in diameter, arising ventral to the sacrum and extending down to the right buttock, was completely removed. Complete relief of symptoms followed. The pathologic diagnosis was polycystic dermoid containing fat and hair.

Case 4.—A girl, age seven months, was brought to the clinic June 23, 1928. Since birth she had had a large mass in the sacrococcygeal region posteriorly. Roentgenograms revealed lower lumbar and sacral spina bifida. On June 28, 1928, the mass, which measured 25x15x10 cm., was removed from the sacrococcygeal region. A second mass, about 7x5 cm., and ventral to the sacrum, was later found and this also was removed. Recovery was complete. The pathologic diagnosis was dermoid cyst.

Case 5.—A woman, age 48, registered at the clinic September 23, 1929. She complained of distress in the lower part of her pelvis and rectum of six months' duration. Rectal examination revealed a fluctuating mass ventral to the sacrum, 2 cm. above the anal margin. Roentgenograms of the sacrum were negative. On September 27 the fluctuating mass was incised and about 100 cc. of thick pus escaped. The thick-walled sac was removed and recovery was complete. The pathologic diagnosis was dermoid cyst.

Case 6.—A woman, age 40, registered at the clinic December 5, 1932. She had had a dull pain in the lower part of her abdomen and sacral part of her back for 15 years. A perirectal draining sinus had been present since incision of an abscess years before. Rectal examination revealed a hard, irregularly lobulated mass arising from the left lateral wall of the sacrum. On December 8, 1932, the mass was incised and 120 cc. of putty-like matter escaped. Marked inflammation was present. The mass was excised as completely as possible. Slight drainage persisted intermittently for some time. The pathologic diagnosis was dermoid cyst.

Case 7.—A woman, age 44, registered at the clinic August 9, 1934. For three months she had noticed some discomfort in the rectum after a bowel movement. She had accidentally discovered a "tumor" in her rectum three months prior to registration while giving herself an enema. Rectal examination revealed a smooth soft mass ventral to the sacrum, and roentgenograms revealed spina bifida of the fifth lumbar and first sacral vertebrae. On August 21, 1934, a mass measuring about 7x5 cm. was enucleated from the ventral portion of the sacrum. Recovery was complete. The pathologic diagnosis was dermoid cyst.

Case 8.—A girl, age two and one-half years, registered at the clinic June 24, 1935. She had had a gradually enlarging tumor over the lower end of the sacrum since birth. Rectal examination revealed a mass measuring 4x8 cm., ventral to the sacrum and palpable just within the rectal sphincter. Roentgenograms revealed an anomaly of the last sacral vertebra. On June 28, 1935, a cystic mass filled with thick creamy material

was found extending from the coccyx to the ventral surface of the sacrum; it was completely removed. It measured 5x4x3 cm. Drainage persisted for some time. The pathologic diagnosis was dermoid cyst.

Case 9.—A woman, age 33, registered at the clinic July 6, 1936. She had had a dull constant ache in the lower part of her back for more than 15 years. Rectal examination revealed a mass 10x6x4 cm., lying ventral to the sacrum and to the left of mid-line. It was fixed and was not tender. Roentgenograms revealed a soft tissue shadow in the lower part of the pelvis. On July 10, 1936, the mass, which was found to be well encapsulated, was removed in its entirety. Recovery was complete. The pathologic diagnosis was dermoid cyst.

It is interesting that each of these nine patients was a female. Three of them were infants, and the average age of the other six was 36. The infants presented sacrococcygeal tumors at birth, two patients had had symptoms for 15 or more years, and four patients had had symptoms for from three to seven months. In two cases incision of an "abscess" had been performed; this was followed by a persistent discharge until the time of excision of the dermoid cyst. Roentgenograms were made in seven cases, and in two cases associated lumbar and sacral spina bifida was noted. In one case there was an anomalous last sacral vertebra.

The symptoms are not pointedly suggestive. Four patients complained of dull aching distress in the lower part of the back or abdomen, or in the rectum. One patient complained of a perirectal draining sinus, and one complained of partial urinary and rectal incontinence. The three infants presented definite evidence of a tumor. Rectal examination revealed the mass ventral to the sacrum in seven cases; rectal examination was not made in the cases of two infants. In those cases uncomplicated by a draining sinus or a previous operative attempt at drainage or removal, rectal examination revealed smooth fluctuant masses which were movable or only partially fixed and were not tender on pressure. In cases complicated by previous operation to institute drainage, marked inflammatory reaction may occur about the tumor and it may then become fixed and tender.

The posterior surgical approach is the one of choice. Complete removal of the lining of the dermoid cyst is essential and, usually, complete enucleation can be carried out without difficulty. If this is done the wound heals rapidly and complete relief of symptoms will follow.

TERATOMATA.—Teratomata are tumors in which tissue representing all three embryonal layers are arranged in disorderly fashion. Their origin is not well defined, various theories having been presented which are based on either their bigerminial or monogerminal origin. The bigerminial theory explains the origin of such tumors as an independent development of a blastomere during segmentation, a rudimentary duplication, or the so called parasitic twin. The monogerminal theory explains their origin as disorderly growths of remnants of fetal structures.

In the ventral sacrococcygeal region there are possibly sufficient fetal remnants to explain the various types of teratomata without resorting to the bigerminial theory of rudimentary twin. Middeldorp was the first to attribute teratoma ventral to the sacrum to the persistence of a fetal structure. He pre-

sented the case of a girl, one year old, who had had a tumor in the region of the anus since birth. It opened to the outside and occasionally discharged a dark brown mucoid fluid. There was no connection with the rectum. This tumor was composed of fatty tissue containing a structure resembling a small loop of intestine. He believed that the tumor was derived from the postanal gut. Hansmann⁷ was of the opinion that when the neurenteric canal remnant was the source of a tumor, there was frequently an associated anterior sacral defect.

Teratomata are most frequently found in the newborn and in infants. The attachment to the rectum is not intimate, but it may be to the sacrum or coccyx; they may be attached to the sacrum by a pedicle or may be enveloped in a capsule.

Case 1.—A girl, age seven, was brought to the clinic June 20, 1929. A large mass protruding from the perineal region had been noted since birth. Rectal examination was not made. Roentgenograms revealed a large soft tissue mass in the pelvis containing fragments of bone. The sacral curve was absent. At operation, June 25, 1929, the mass was found to be attached to the ventral median raphe of the sacrum and coccyx, displacing the genitalia downward and anterior. This mass was completely removed. It weighed 550 Gm. The perineal portion measured 10x7 cm. and the portion ventral to the sacrum was 9 cm. in diameter. Recovery was complete. The pathologic diagnosis was teratoma.

MISCELLANEOUS TUMORS.—This group of tumors ventral to the sacrum consisted of three malignant tumors (a fibrosarcoma, chondromyosarcoma, and a squamous cell epithelioma, possibly vesical in type) and one benign tumor (fibroma). There was no evidence of malignancy elsewhere in any of the cases of malignant tumor. Two of these patients with malignant lesions had symptoms of nerve root pressure; the third complained only of pain and constipation. In the case of the fibroma there was marked inflammatory fixation, which permitted only partial removal.

Case 1.—A man, age 51, registered at the clinic July 9, 1928. He had had a dull aching pain in the rectum, bearing down in type, of increasing severity for one year. Weakness in his legs had been present for six months, sciatica for two months, and urinary difficulty for two months. Rectal examination revealed a relaxed sphincter and an irregular, nontender mass ventral to the sacrum. Roentgenograms of the pelvis were negative. On July 18, 1928, a large tumor, 10x15x5 cm., was found eroding the ventral surface of the sacrum. The mass was removed almost in its entirety; it weighed 122 Gm. The patient died one year later. The pathologic diagnosis was fibrosarcoma.

Case 2.—A man, age 73, registered at the clinic November 29, 1934. He had had a mass in the coccygeal region with pain on sitting for eight months. Constipation had been present for six months. He had lost 35 pounds (15.9 Kg.) in the two years prior to his registration. Rectal examination revealed a firm mass ventral to the sacrococcygeal area, and roentgenograms revealed destruction of the lower part of the sacrum and coccyx. A soft tissue shadow was present. On December 12, 1934, the tumor, which had encroached on the rectum, was incompletely removed. It weighed 350 Gm. Again on January 14, 1936, a recurrent tumor about 6x4 cm. was removed. Radium treatment was instituted and there was some improvement. The pathologic diagnosis was chondromyxosarcoma.

Case 3.—A man, age 53, registered at the clinic December 26, 1931. He had had severe sciatic like pain, shooting in character, for four months. Some numbness and tingling of the left leg had also been present for four months. Rectal examination revealed a hard, fixed mass behind the rectum ventral to the sacrum. It was not tender. Roentgenograms of the pelvis were negative. At operation January 5, 1932, the mass,

which was found to be high in the hollow of the sacrum, was incompletely removed. Extensive radiotherapy followed. The patient died six months later. At the time of his examination and at operation no other evidence of malignancy was found. The pathologic diagnosis was squamous cell epithelioma, possibly vesical in type.

Case 4.—A woman, age 29, registered at the clinic February 15, 1929. She had had a dull aching pain, without projection, in the sacral region for six months. Rectal examination revealed a mass posterior to the rectum. The mass was rounded, smooth, not tender, and extended almost to the promontory of the sacrum. At operation, March 1, 1929, the mass was found to be quite fixed and edematous. It was incompletely removed. The pathologic diagnosis was fibroma.

SUMMARY

Tumors arising ventral to the sacrum probably arise from remnants of fetal structures. The most important fetal changes in this region include the development and subsequent disappearance of the notochord, neurenteric canal, proc-todeum and hindgut.

The subjective symptoms of tumor ventral to the sacrum are not definitely suggestive but include pain in the sacral region, constipation, and vesical and rectal incontinence. Rectal examination revealed the mass in each case in which it was made. It is the most important single diagnostic procedure.

The most satisfactory treatment of such tumors is surgical excision through a modified Kraske type of posterior incision. In the case of malignant tumors complete removal is often difficult and radiotherapy may help to relieve pain and to prolong life.

The incidence of recurrence is high, and recurrence is usually local. The prognosis varies with the type of tumor, being poor in instances of malignancy.

REFERENCES

- ¹ Chesky, V. E.: Sacrococcygeal Chordoma. *Arch. Surg.*, **24**, 1061-1067, June, 1932.
- ² Cunningham, D. J.: *Textbook of Anatomy*. Ed. 5. New York, William Wood and Company, 27-55, 1923.
- ³ Ewing, James: *Neoplastic Diseases: A Treatise on Tumors*. Ed. 3. Philadelphia, W. B. Saunders Company, 1035, 1928.
- ⁴ Feldmann, I.: Chordoma Ossis Sacri. *Beitr. z. path. Anat. u. z. allg. Path.*, **48**, 630-634, 1910.
- ⁵ Fletcher, Eleanor M., Woltman, H. W., and Adson, A. W.: Sacrococcygeal Chordomas: a Clinical and Pathologic Study. *Arch. Neurol. and Psychiat.*, **33**, 283-299, February, 1935.
- ⁶ Galletly: Quoted by Raven, R. W.: Sacro-coccygeal Cysts and Tumors. *Brit. Jour. Surg.*, **23**, 337-361, October, 1935.
- ⁷ Hansmann, G. H.: A Congenital Cystic Tumor of the Neurenteric Canal: with Special Reference to Its Histology and Pathological Significance. *Surg., Gynec. & Obstet.*, **42**, 124-127, January, 1926.
- ⁸ Hundling, H. W.: Ventral Tumors of the Sacrum. *Surg., Gynec. & Obstet.*, **38**, 518-533, April, 1924.
- ⁹ Linck, A., and Warstat: Quoted by Kwartin, Boris, and Stewart, J. D.: Sacrococcygeal Chordoma. *ANNALS OF SURGERY*, **86**, 771-775, November, 1927.
- ¹⁰ Middeldorpf, K.: Zur Kenntniss der angeborenen Sacralgeschwülste. *Virchow's Arch. f. path. Anat. u. Physiol.*, **101**, 37-44, July, 1885.
- ¹¹ Ribbert: Über die Echondrosis Physalifora Sphenooccipitalis. *Centralbl. f. allg. Path. u. path. Anat.*, **5**, 457-468, 1894.
- ¹² Stewart: Quoted by Harmos, Oscar, and Palmer, L. A.: Chordomata and Report of Case. *Virginia Med. Month.*, **62**, 638-648, February, 1936.

INTRAMEDULLARY DERMOID CYST

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DERMOID and epidermoid tumors within the spinal canal are of infrequent occurrence. About one-third of those reported are intramedullary tumors. But of the intramedullary group, epidermoid tumors are much more common than true dermoid cysts.

Gross⁵ collected from the literature 19 dermoid and epidermoid tumors within the spinal canal to which he added one. In order to bring the literature up to date the following additional cases of dermoid and epidermoid tumors have been collected and classified as carefully as the original papers permit.

Shallow's¹⁵ patient was a man, age 30, who had had pain in the lumbar region, urinary retention, and hyperesthesia of the sacral dermatomes for three years. At operation an extramedullary tumor filling the spinal canal at the level of the fourth lumbar vertebra and compressing the cauda equina was removed with subsequent improvement. The cyst was lined by cornified, stratified squamous epithelium and contained many sebaceous glands and a few hair follicles. Through the courtesy of Dr. B. L. Crawford of the Jefferson Hospital in Philadelphia I was able to examine sections of this tumor. It is classified as an extramedullary dermoid cyst.

Delrez⁴ reported the case of a female, age 5, who for four months had had urinary and fecal retention, a paraplegia, and anesthesia of the sacral dermatomes. At operation an extradural tumor involving the cauda equina extended from the third lumbar to the first sacral vertebra. The tumor which contained grayish-yellow cheesy material was removed with resulting improvement. One year later the patient died of a metastasizing abdominal tumor which the author considered a sarcoma of the kidney. No necropsy was performed. No description of the microscopic appearance of the surgical specimen is given. The pathologist's diagnosis of dermoid cyst must, therefore, be accepted provisionally.

The case reported by Craig and Mitchell³ was that of a boy, age 8, who gave a history of pain in his back, tired feeling in the lower extremities, and occasional enuresis for three years. The only neurologic findings were absent knee jerks and hyperesthesia of both groins. The tumor disclosed at operation was extramedullary, 3.6 cm. in length, compressing the conus medullaris and cauda equina at the level of the last thoracic and first lumbar vertebrae. The patient was relieved of all symptoms. The tumor contained the typical crumbly, pearly contents of an epidermoid growth. Microscopic examination revealed a lamellated appearance, but no nuclei. The tumor is classified as an extramedullary epidermoid of cholesteatomatous type.

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Schroeder's¹⁴ patient was a woman, age 35, who had had a paraplegia and hypesthesia below the second lumbar dermatome for 18 months. At operation an extramedullary tumor 2.5 cm. long was removed at the level of the last two thoracic vertebrae where it compressed the conus medullaris. The patient recovered. The tumor was cystic, filled with yellowish white material. Microscopically the cyst was lined with cornified, stratified squamous epithelium. The tumor is an extramedullary epidermoid.

Bouchut, Déchaume, and Michailidis¹ have reported the case of a man, age 71, who had had pain in his lower extremities of 15 years' duration which lessened as motor difficulty increased. Urinary retention had been present for ten years. Examination showed a paraplegia and hypesthesia of the last lumbar and all the sacral dermatomes. At necropsy an intramedullary tumor of the conus medullaris was found to have enlarged the cord so that it filled the canal at the level of the twelfth thoracic vertebra. On section the cyst which filled the cord was seen to contain an oily, pearly, lamellated substance which was assumed to be sloughed layers of epidermis. In addition, there was a dysembryoplasia of the adjacent portions of the spinal cord with muscle, glial tissue, and syringomyelic cavities lined by epithelium with the appearance of ependyma. This is concluded to be a case of intramedullary epidermoid of cholesteatomatous type associated with a malformation of the spinal cord.

Ottonello's¹² patient was a woman, age 20, who had had pain in the scapular region one year before with the gradual appearance subsequently of paresis and sensory loss in her lower extremities. Physical examination revealed a dimple at the level of the third thoracic vertebra through which a sinus emptied. At operation an extramedullary tumor 6.5 cm. long and 2 cm. wide, which had compressed the cord at the second, third, and fourth thoracic vertebrae, was removed and along with it a sinus which connected the tumor to the dimple just mentioned. The cyst contained sebaceous material and many hairs. The lining of the cyst was a poorly developed stratified squamous epithelium. Although it was obstructed in places, the sinus communicated with the cyst. More superficially the sinus contained in its wall abundant hair follicles and sebaceous and sudoriferous glands. But these gradually diminished in number in the deeper portions and had disappeared entirely where the sinus communicated through the dura mater with the cyst. This case is classified as an extramedullary dermoid cyst and congenital dermal sinus.

Hipsley⁶ reported, as a dermoid cyst within the spinal canal, a case which appears to be one of congenital dermal sinus. A female, age 3, had at the level of the first thoracic spine a sinus which had been draining. For four weeks there had been difficulty in walking and severe pain in the left chest. Examination revealed a red area 2.5 cm. in diameter around the sinus opening from which a few hairs could be seen protruding. A probe passed easily into the sinus to a depth of 2.5 cm. Attempts to flex the thoracic spine were resisted. At operation the spine of the second thoracic vertebra was found to be bifid and through a perforation in its base, sebaceous material escaped.

An extramedullary mass, 1.8 cm. long and 1.2 cm. wide, was firmly adherent to the dura mater. It was removed with subsequent improvement of the patient. The meager description given states: "The contents and lining of the cyst resembled the contents and lining membrane of a sebaceous cyst of the skin." It seems probable that this is simply a case of congenital dermal sinus, chronically infected, symptoms occurring when drainage ceased from obstruction of the sinus. The hairs protruding from the ostium rule out any other kind of sinus. It would, however, be possible that the cystic mass removed at operation was a dermoid cyst combined with a congenital dermal sinus as in the case reported by Ottonello.

Of the four cases recently reported by Naffziger and Jones¹¹ the third case is omitted here because it is very doubtful that it comes within the group described in this paper. The first and fourth cases were dermoid cysts; the second, an epidermoid. The first case was subarachnoid; the second and fourth, subpial. Roentgenologic changes, consisting of erosion of the pedicles and bodies of the vertebrae, occurred only in the first two cases. There was in addition a sacral spina bifida in the first case of the series.

The first case occurred in a woman, age 62, who had complained of pain in her back for 42 years and a paraplegia for one year. A tumor 15.2 cm. long and 3.8 cm. wide involving the cauda equina from the twelfth thoracic to the second sacral vertebrae was partially removed with almost complete recovery subsequently. Most of the mass removed was a crumbly, fatty material containing many hairs; but there was also a portion of capsule which revealed, upon microscopic examination, a thinned-out layer of stratified squamous epithelium.

The second case was in a woman, age 27, who developed incontinence of urine and feces following pain in her back for two years. A cystic tumor weighing 9 Gm. involving the conus medullaris from the last thoracic to the second lumbar vertebrae was removed with good improvement. The cyst was lined with a stratified squamous epithelium.

The fourth case occurred in a man, age 45, who had suffered with urinary symptoms for 16 years. During the last two years pain in the sacral dermatomes and a paraparesis had developed. At operation a subpial tumor 5.5 cm. long was found extending from the eleventh thoracic to the third lumbar vertebrae. Below, it compressed the cauda equina and it was possible to separate the capsule; but above, the capsule merged with the conus medullaris from which it had to be severed. Microscopically there was found to be a hyperkeratotic, stratified squamous epithelium beneath which were scattered hair follicles, sebaceous and sweat glands, and fat cells.

Puech, Plichet, Visalli, and Brun¹³ have reported the case of a man, age 37, who had had paresthesias, paraparesis, and urinary disturbance for one year. At operation an intramedullary tumor weighing 4 Gm. was removed piecemeal at the level of the sixth and seventh thoracic vertebrae with subsequent recovery. Microscopic examination revealed only a rather struc-

tureless, lamellated mass without cells. This tumor can be classified as an intramedullary epidermoid of cholesteatomatous type.

A case pathologically very similar to the one here presented has been reported by Love and Kernohan.⁸ A man, age 40, had complained of a progressive paraparesis and incontinence. Following the demonstration with lipiodol of a subarachnoid block opposite the second lumbar vertebrae, a laminectomy was performed which revealed a cystic mass within the conus medullaris. On incision of this, grumous material, hair and material resembling pus escaped. The wound healed without infection, but the patient's neurologic condition was little altered. Diagnosis: Intramedullary dermoid cyst.

SYNOPSIS OF CASE REPORT

The patient, a male, age 3, developed normally until one year before admission when pain occurred at irregular intervals in both lower extremities; two months prior to admission pains became more severe, and were accompanied by fecal and urinary incontinence and inability to walk. Examination showed a rather flaccid paraparesis, peri-anal analgesia, and a palpable defect in the sacral laminae. Roentgenologic examination revealed marked dilatation of the lumbar canal. Operation was performed consisting of incision and evacuation of an intramedullary dermoid cyst and excision of a mural nodule. Subsequent improvement occurred.

Case Report.—No. 157304. D. W., male, age 3, was first seen by the Pediatric Service of the University of Chicago Clinics August 7, 1936. Chief complaint: "Pain in lower extremities and inability to walk for six weeks."

The patient was the only child of a mother, age 20. The birth weight was six pounds, six ounces. The pregnancy and delivery were normal. Both parents were in good health and there was no history of familial disease. The child sat up at six months, talked at 12 months, and walked at 13 months. Dentition was normal, and the patient had been continuously well except for his present illness.

In August, 1935 (age two), the patient first complained of pains in both lower extremities. These were described as being intermittent and worse first in one place, then in another. These pains progressed for almost a year before other symptoms developed.

In June, 1936 (age three), the pain was so severe that the patient asked to be carried when going somewhere instead of walking as formerly. It was soon evident that the lower extremities were too weak for the patient to walk although he could be held in a standing position and take a few steps. The patient also became incontinent of feces and urine although he had previously had perfect control. Since June, 1936, the patient had been extremely irritable and uncomfortable, frequently refused to eat, and had lost seven pounds in weight.

Examination August 7, 1936, revealed a well developed, thin, blond male, apprehensive and irritable. Temperature normal; complete blood count and uranalysis were negative; weight 26 pounds. The patient lay supine with his legs moderately flexed and objected to other positions. He was quite intelligent and bright as was evident when his apprehension was overcome. The chest and abdomen were negative. The left testis was undescended, but the genitalia were otherwise normal. The teeth were in good condition and the nose and throat normal.

Neurologic Examination revealed a normal head, but the neck was slightly stiff and the patient complained when it was flexed. The cranial nerves were normal throughout. Motor function, sensation, and reflexes were normal in the upper extremities and trunk. The abdominal reflexes were active and equal. Motor function was very difficult to determine in the lower extremities. The patient complained when his

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legs were manipulated in any manner, especially upon the Kernig test. All movements seemed possible, but the patient was reluctant to use his extremities because of pain. Atrophy was present in the left buttock, but to no great extent elsewhere. The limbs were flaccid although not extremely so. Sensation to pin prick, judged by the patient's responses, was normal except in the peri-anal region where little response to painful stimuli was obtained. The plantar reflexes were normal. The tendon reflexes were variable and hypo-active although both knee jerks and both ankle jerks were obtainable. When supported, the patient could stand, keeping his knees and hips flexed. A few faltering steps were possible when the patient was well supported, but it was impossible

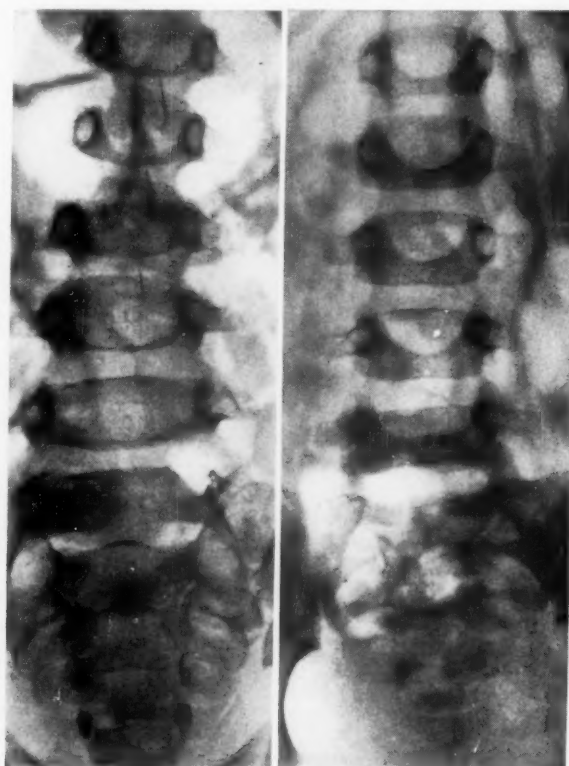


FIG. 1.—On the left is a reproduction of the roentgenogram of the lumbosacral spine of the patient with an intramedullary dermoid cyst. On the right a roentgenogram of a normal lumbosacral spine in a child of the same age has been reproduced for comparison. The dilatation of the spinal canal without any appreciable thinning or deformity of the pedicles is clearly shown.

for him to stand or walk alone. Over the lumbosacral joint was a tuft of blond hair several centimeters long, and at the tip of the coccyx a dimple was present, but the skin was intact and not inflamed nor did any sinus lead from it. Palpation over the sacrum revealed an absence of the sacral laminae.

Roentgenologic Examination August 7, 1936, revealed a remarkable dilatation of the spinal canal in the region of the fourth and fifth lumbar and the first sacral vertebrae (Fig. 1). There was a failure of fusion of the laminae of the fourth lumbar vertebra and for this age, normal lack of fusion of the lumbar and the sacral vertebrae.

A preoperative diagnosis of spina bifida occulta with intraspinal tumor or myelodysplasia was made.

Operation.—August 11, 1936: Dr. Paul C. Bucy performed a laminectomy of the last four lumbar and the first sacral vertebrae. The spines and laminae were normal except that the fourth lumbar vertebra contained a small defect in the laminae besides an incompletely developed spinous process. The fifth lumbar contained a somewhat larger defect, and the first sacral vertebra had the developing bone of the spinous process and laminae still separate from the remainder of the vertebra. At the level of the fourth and fifth lumbar vertebrae the canal was grossly enlarged and the dura mater was quite tense. Upon incising the dura mater it was apparent that a tremendously dilated spinal cord entirely filled the caudal end of the dural sac. The greatest dilatation of the spinal cord was at the level of the fourth and fifth lumbar vertebrae where it was

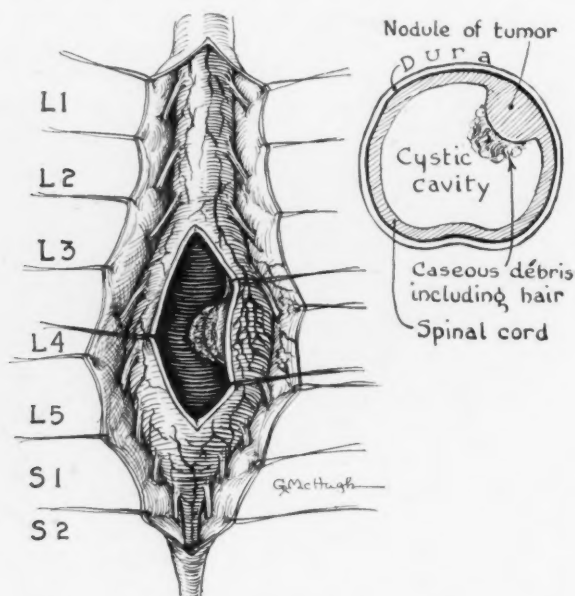


FIG. 2.—The drawing at the left represents the appearance at operation. The cord has been incised between the posterior columns, exposing a large cystic cavity which extends both above and below the incision. A nodule is seen on the right, its inner surface covered with caseous debris and hair. There are numerous small blood vessels over the surface of the thinned portion of spinal cord to which the nodule is attached. At the right is a diagrammatic cross section through the conus medullaris at the level of the nodule.

increased to four or five times the normal size. Above this level, extending to the third lumbar vertebra, the dilatation was to about twice the normal size. At the top of the exposure the dura mater pulsed normally. On the right side at the fourth lumbar vertebra there was on the surface of the dura mater a tangle of arteries and veins considerably more extensive than elsewhere. With the dura mater open it could be seen that five or six of these vessels passed to the spinal cord with a corresponding increase in vascularity at this point. The posterior roots taking their origin in the tensely dilated spinal cord could be seen coursing caudally and laterally over it. Because of its cystic appearance the spinal cord was aspirated and 12 cc. of whitish yellow, opaque fluid were obtained. On microscopic examination this showed many epithelial cells. The cord was then incised longitudinally between the posterior columns exposing a cyst lined by a translucent membrane (Fig. 2). More fluid was obtained and several masses of caseous material in which were mingled many fine blond hairs. With the collapse of the spinal cord it was evident that the vessels entering its right side at the level of the

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fourth lumbar vertebra passed into a nodule in the cord which constituted a part of the cyst wall. Considerable caseous material containing hair was loosely adherent to the nodule. The nodule was extirpated; bleeding was controlled by means of silver clips. In addition a portion of the lining of the cyst at a considerable distance from the tumor nodule was removed for examination. All the fluid and caseous material was carefully evacuated and the incision in the spinal cord left open. At the lower end of the dural sac, at the junction of the first and second sacral vertebrae, the spinal cord terminated in a small, round structure comparable to the filum terminale which passed out of the dural sac and merged into the surrounding fatty tissue. The dura mater was closed with fine silk sutures and the muscles and skin approximated with layers of interrupted silk sutures.

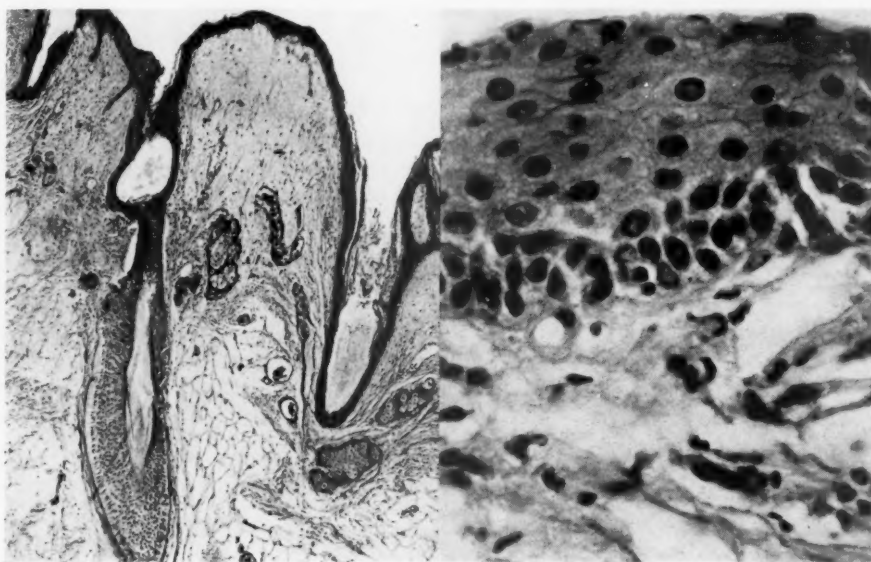


FIG. 3.—On the left the dermoid nodule is seen magnified 50 diameters. A well-developed hair follicle and three sebaceous glands are observed. On the right is seen the noncornified, stratified squamous epithelial lining of the cyst several centimeters away from the nodule, magnified 540 diameters. Both sections are stained with hematoxylin and eosin.

Postoperative Course.—Following the operation the patient no longer complained of pain in his lower extremities. The wound healed promptly and the patient was discharged on the thirteenth postoperative day. During the month following discharge the patient regained sphincter control and began to walk, at first holding on to things. Apparently, however, at this time he was overactive, because subsequently pain recurred in the lower extremities and the patient did not walk for about a month. Since this time the patient has constantly improved in the use of his lower extremities. However, urinary incontinence has recurred, although rectal control is good. When last seen, in February, 1937, the patient walked and ran easily although he kept his trunk flexed forward on the pelvis. There was a weakness of the dorsiflexors of the right ankle. Sensory examination and tendon reflexes were normal.

Microscopic Examination.—Smear of the fluid removed at operation revealed many large, flat, polyhedral cells, frequently joined together in groups of six or eight. The nuclei were small and evenly staining, the cytoplasm finely granular and very slightly eosinophilic. It was concluded that these were squamous epithelial cells. The nodule removed showed everywhere a stratified squamous epithelial lining of which only about half was cornified. The dermis contained fat, hair follicles, and sebaceous glands (Fig.

3). Marked gliosis was present in the contiguous portion of the spinal cord. The portion of cyst wall removed at some distance from the nodule showed an uncornified, stratified squamous epithelium and only a thin layer of connective tissue beneath separating it from the sclerotic spinal cord. No dermal structures were present in this portion.

There can be little doubt that these findings represent a developmental defect in the cleavage of the surface and neural ectoderm similar in many respects to the developmental anomaly responsible for the development of extramedullary dermoid and epidermoid tumors elsewhere in the central nervous system and to the congenital dermal sinuses reported by Walker and Bucy.¹⁶ In this particular instance the bit of surface ectoderm responsible for the tumor has remained firmly attached to the neural groove and become enfolded within that structure upon its closure to form the neural tube and eventually the spinal cord. It seems likely that the nodule composed of dermal and epidermal structures represents the original implant and that the cystic cavity and its lining of stratified squamous epithelium have resulted from secretion from the dermoid nodule and the progressive enlargement and lining of this cavity from the "mother" epithelium present on the nodule. It is to be hoped that removal of the dermoid nodule will terminate this progressive process since extirpation of the epithelial lining of this large cyst was not feasible.

Discussion.—In the 20 cases included by Gross⁵ in his report, five were intramedullary (Chiari,² Ivanoff,⁷ Marinesco and Draganesco,⁹ Melnikoff-Raswedenkoff,¹⁰ and Gross⁵). Only that of Ivanoff was a dermoid cyst. It occurred in an anencephalic monster, extending throughout the spinal cord and bulb. It is hardly comparable to the case herein described where there were no apparent congenital defects except the tumor in the caudal end of the spinal cord and minor changes in the caudal portion of the spine. Twelve additional cases have been found in the literature to which the one here reported is added. The cases of Bouchut and of Puech bring the total number of intramedullary epidermoid tumors to six. Only the case of Ivanoff, that of Love and Kernohan, and the one presented here were intramedullary dermoid cysts. Ten of the 13 cases involved the region of the conus medullaris and cauda equina. Of the three cases in the upper thoracic region two were accompanied by spina bifida and congenital dermal sinuses.

The similarity in structure and development of dermoid tumors and congenital dermal sinuses should be mentioned. Both are due to improper separation of the neurectoderm from the surface ectoderm. A congenital dermal sinus, a dermoid tumor, or a combination of both may develop, depending upon whether or not the portion of surface ectoderm present in the region of the neural tube, as an inclusion, retains an epithelial connection with the surface.

SUMMARY.—A case of intramedullary dermoid cyst in a male child three years old is reported and the literature reviewed. Epidermoid and dermoid tumors within the spinal canal are dysraphisms of the same general nature as congenital dermal sinuses.

REFERENCES

- ¹ Bouchut, Déchaume, J., and Michailidis: Kyste cholestéatomateux intramédullaire par dysembryoplasie nerveuse. *Lyon méd.* **150**, 694-697, December 18, 1932.
- ² Chiari: Centrales Choleastom des Dorsalmarkes. *Prager med. Wchnschr.*, **39**, 378-380, 1883.
- ³ Craig, J., and Mitchell, A.: Spinal Tumors in Childhood. *Arch. Dis. Childhood*, **6**, 11-16, 1931.
- ⁴ Delrez, L.: Kyste Dermoïde Rachidien et Sarcome du Rein Chez le même Enfant. *Liège méd.*, **22**, 1667-1675, December 15, 1929.
- ⁵ Gross, Sidney W.: Concerning Intraspinal Dermoids and Epidermoids, with Report of a Case. *Jour. Nerv. and Ment. Dis.*, **80**, 274-284, September, 1934.
- ⁶ Hipsley, P. L.: Dermoid Cyst of Spinal Canal. *Australian and New Zealand Jour. Surg.*, **2**, 421, April, 1933.
- ⁷ Ivanoff, N. S.: A Case of Cholesteatoma of the Spinal Cord. *J. Neuropat. i. psikiat.*, Korsakova, Mosk., pp. 80-81, 1903.
- ⁸ Love, J. G., and Kernohan, J. W.: Dermoid and Epidermoid Tumors of Central Nervous System. Reprinted with additions from *J.A.M.A.*, **107**, 1876-1882, December 5, 1936.
- ⁹ Marinesco et Draganesco: Kyste Epidermoïde Cholestéatomateux de la Moelle Épineière. *Rev. Neurol.*, **40**, 338-355, 1924.
- ¹⁰ Melnikoff-Raswedenkoff, N.: Über epidermoide und dermoïde Cholesteatome des Grosshirns und Rückenmarks. *Deutsch. Ztschr. f. Nervenhe.*, **127**, 123-130, 1932.
- ¹¹ Naffziger, H. C., and Jones, O. W.: Dermoid Tumors of the Spinal Cord. *Arch. Neurol. and Psychiat.*, **33**, 941-958, May, 1935.
- ¹² Ottonello, Paolo: Dermoïde spinale associato a rachischisi. *Riv. di pat. Nerv.*, **41**, 512-531, May-June, 1933.
- ¹³ Puech, P., Plichet, A., Visalli, F., and Brun, N.: Cholestéatome intramédullaire. *Rev. Neurol.*, **66**, 56-62, July, 1936.
- ¹⁴ Schroeder, A. H.: Cholesteatoma medular. *An. Frac. de med. Montevideo*, **17**, 591-616, August, 1932.
- ¹⁵ Shallow, Thomas A.: Dermoid Cyst of the Cauda Equina. *Surg. Clin. N. Amer.*, **8**, 885-889, August, 1928.
- ¹⁶ Walker, A. E., and Bucy, P. C.: Congenital Dermal Sinuses. *Brain*, **57**, 401-421, December, 1934.

TEARS OF THE SUPRASPINATUS TENDON

RÉSUMÉ OF TWELVE OPERATED CASES

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IT WOULD seem almost unnecessary, in view of the complete and painstaking monograph of Codman, to attempt to present additional material on lesions of the supraspinatus tendon, but because of the scarcity of medical literature dealing with this subject and the fact that we believe that the diagnosis of such injuries more often than not goes unrecognized, we are presenting a brief and admittedly incomplete résumé of the salient points in the condition of supraspinatus tendon tear in conjunction with a report of a group of cases operated upon by the senior author.

Between 1928 and 1934, we diagnosed this condition three times; since 1934 we have seen and diagnosed 14 cases in this clinic, of which 12 have come to operation, at which time the lesion was demonstrated and a repair of the tendon effected. It would appear from what we have learned in these recent cases, that we have previously seen other instances, many of them less well defined symptomatically, without recognizing the real condition, and for this reason we wish to emphasize the necessity for careful study of all obscure cases of shoulder dysfunction.

Anatomy.—The tendinous insertion of the supraspinatus, together with the infraspinatus, teres major and teres minor (forming the musculotendinous cuff) is closely attached to the capsule of the shoulder joint, reinforcing the latter in its upper half. While standard anatomic text-books state that the supraspinatus is inserted into the upper facet of the greater tuberosity, it is so intimately blended with the contiguous infraspinatus as to be indistinguishable from it.

Its function is to pull the greater tuberosity under the acromion, fix the humeral head in the glenoid, and abduct the shoulder through the first few degrees, at which point the deltoid assumes the burden and continues the motion throughout the arc of scapulohumeral motion.

Etiology.—Rupture of the supraspinatus, though certain factors may predispose to it, is traumatic in origin. The injury apparently may occur in one of two ways—either in falling the patient abducted his arm in an attempt to break the fall, the rupture occurring during the movement before the shoulder struck the ground, or a direct blow (or fall) was received on the back of the shoulder with production of a forward displacement of the humeral head with consequent rupture of the tendon. Dislocation of the shoulder may occur or the displacement may be only momentary, followed by spontaneous replacement.

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According to Codman and Akerson⁴ the tendon may have been previously weakened as the result of: (1) Defects left as a result of so called calcified deposits; (2) necrosis of the tendon or other diffuse pathologic process or of the same phenomena which are known as arthritis in other joints; (3) attrition. Finally, age may be considered as a predisposing factor since the condition is commonly seen in patients around or beyond the fifth decade.

PATHOLOGY.—The site of rupture of the supraspinatus is commonly at, or very close to, the greater tuberosity. The proximal fragment then retracts, enlarging the gap and frequently tearing the floor of the bursa, thus creating an opening through which there is a direct communication between the bursa and shoulder joint.

Diagnosis.—The fact that in no instance when a diagnosis of supraspinatus tear was made have we been unable to demonstrate the lesion is good evidence that the symptomatology is clear cut. Codman has outlined 18 conditions, symptoms, and signs which indicate complete rupture of the supraspinatus. Of these, we have found the following objectives signs of greatest importance:

(1) Diminution or loss of the power to abduct. This varies with the size of the tear and also with the nervous make-up and fortitude of the patient.

(2) Tenderness over the greater tuberosity. Dawbarn's sign has not been of especial help, since there may be hyperesthesia in the distribution of the circumflex nerve.

(3) Undue prominence of the greater tuberosity due to the fact that its tendinous covering is absent.

(4) Crepitus of a fine nature, palpable over the tuberosity as it moves under the acromion on passive motion of the arm.

(5) A negative roentgenogram.

Description of a Typical Lesion.—In Wilson's³ cases all the tears were of the complete type, the largest rent measuring two and one-half inches and involving the subscapularis and infraspinatus tendons as well. The commonest tear measures about one and one-half inches, is roughly triangular in shape with the base toward the greater tuberosity and the apex of the tear may extend up under the acromion, especially in old cases. The underlying joint capsule is nearly always torn through exposing the inside of the joint. The edges of the tendon are ragged and thinned, and calcification may be present in the cases of long standing. As a rule, very little tissue remains attached to the greater tuberosity. The head of the humerus is unaffected in the early case. In the average case the insertions of the other short muscles are unaffected. If dislocation occurs, however, rupture in varying degree may be present in the adjacent structures.

Treatment.—The treatment, unless the tear be very small, is operation and suture of the tendon. There is reason to believe that incomplete tears may be successfully treated by rest in abduction.

We have under treatment at the present a patient with classical symptoms

of a tear, but in view of the fact that considerable power in abduction was retained, treatment on an abduction splint was advised. Rest in abduction was carried out until the crepitus disappeared (four weeks), when active motion was started. Progress has been slow and, while the outcome is apparently going to be satisfactory, we feel that operative repair would have shortened the convalescence.

For the complete tear with wide separation, operative repair is the only logical treatment. Usually it is possible to attach the retracted tendon to the tuberosity by one of several methods. Anatomic approximation of the retracted ends and suture with two or three heavy silk mattress sutures is probably the best method and is generally possible in early cases. In the older case where the edges of the tear are ringed with scar tissue, the latter may be excised back to normal tendon, or the sutures may be placed well back in healthy tendon tissue so that the necessary tension can be applied when approximating the fragments. We have preferred this to the former procedure. If there is insufficient tendon attached to the tuberosity to permit simple suture, a groove may be cut in the tuberosity and the proximal portion of the tendon drawn close to the groove and anchored by mattress sutures passed through drill holes made through the tuberosity into the groove. In the older case with such wide retraction that suture is not possible, the remnants of the attachment can be removed and the enlarged and irregular tuberosity may be removed to prevent impingement of the tuberosity on the acromion during abduction. This was done in one case with good results so far as relief of pain was concerned, but with, of course, no improvement in strength.

Following operation the arm is immobilized by the use of an axillary pad, sling and bandage. As soon as the wound is dry, sinusoidal current and "bending" exercises are begun. The latter consists of allowing the arms to hang loosely at the side and then bending forward. In this manner a position of abduction is obtained without muscular effort. At the end of three weeks, supported active motion and active exercises on the finger ladder and the use of a weight and pulley are started. Improvement generally extends over a period of from three to six months.

The following résumé of 12 operated cases is presented. The results have been classified as excellent, good, fair and poor. This classification is, of course, arbitrary, but in general the descriptive terms mean as follows: Excellent—complete relief of pain and from 75 to 100 per cent return of power of abduction; good—pain relieved, active abduction present but considerably weaker than normal; fair—relief of pain, abduction very weak; poor—little or no relief from pain or increase in power of abduction.

CASE REPORTS

Case 1.—S. O., female, age 46, while lifting a heavy object from a shelf felt something snap in her shoulder, which became very weak and painful. Chiropractic treatments did not afford relief. Operation was performed 14 months later. Operative

TEARS OF THE SUPRASPINATUS TENDON

Findings: Complete tear of supraspinatus tendon, floor of bursa, and capsule. Approximation of the tendons was possible. Repair with mattress sutures. Result: Good.

Case 2.—J. L., male, age 59. No definite injury. Does heavy labor. Pain began one week ago. Was unable to abduct arm. No treatment. Kahn test four plus. Operative Findings: Floor of bursa thick and red but not torn, complete tear of supraspinatus tendon and long head of biceps. Both repaired. Result: Good.

Case 3.—C. K., male, age 69. Fell from roof 18 hours previously, striking on shoulder. Typical findings of complete tear, floor of bursa torn, bursa filled with synovial fluid, complete tear of supraspinatus tendon. Result: Four months after operation, good and still improving—probably the eventual result will be excellent.

Case 4.—F. W., male, age 59. Fell three days previously while getting on passenger coach and attempted to break his fall by grasping hand rail. No treatment. Patient known diabetic. Operative Findings: Typical complete tear one and one-half inches long involving both supraspinatus and infraspinatus tendons equally, floor of bursa not ruptured. Result: Good.

Case 5.—M. S., male, age 32. Dislocated shoulder (caught under coal slide December 17, 1934). Shoulder quite weak and stiff. Twice manipulated under anesthesia for peri-arthritis. Passive motion increased but no active abduction and much pain. Operation August 29, 1935. Operative Findings: Bursa not torn, section of bursa discolored and appeared cystic on palpation; floor incised and triangular tear seen, part of superficial fibers intact but thin, deep fibers ruptured. Result: Fair.

Case 6.—N. D. S., female, age 60. Both shoulders dislocated and reduced by manipulation. Right shoulder remained weak in abduction but not painful. Treated by massage. Operated upon 14 months later. Operative Findings: Bursa open, small tear near insertion easily repaired, but about one inch proximally was a large tear involving the supraspinatus and infraspinatus tendon with edges widely retracted. Result: Fair (seen only for six weeks postoperatively).

Case 7.—L. L., male, age 52. Struck by falling barn door one week before examination. Pain not prominent, such pain as was present referred to deltoid insertion. Unable to abduct arm and tender over tuberosity (latter very prominent). No treatment. Operative Findings: Bursal floor torn, complete tear of supraspinatus and infraspinatus tendons, insertion much frayed, biceps not ruptured. Result: Excellent.

Case 8.—J. K. M., male, age 54. Fell from derrick. Severe pain and inability to abduct. Treated with physiotherapy. Operation performed seven weeks later. Operative Findings: Floor of bursa thick and rough but intact, complete tear with wide retraction, very few shreds at insertion. Impossible to approximate tendon and tuberosity removed. Result: Fair, pain relieved, no power in abduction.

Case 9.—T. H., male, age 57. Fell from box car two days before operation. Pain referred to insertion of deltoid, weakness in abduction. Operative Findings: Floor of bursa intact, tuberosity very prominent; area of yellowish discoloration about this; when floor of bursa was incised, a triangular tear three-quarters of an inch wide was seen; yellowish discoloration due to degeneration of tendon about the margins of the tear; yellowish material not amorphous but fibers of tendon apparent in it. Result: Excellent after five months.

Case 10.—D. A., male, age 56. Auto accident 24 hours previously. Fracture dislocation of shoulder. Open reduction effected. Operative Findings: Complete rupture of supraspinatus and subscapularis; long head of biceps intact. Result: Excellent.

Case 11.—B. C., male, age 42. Knocked down by horse eight days previously. Dislocated shoulder. Shoulder reduced. No return abduction; tender over tuberosity. Operative Findings: Small triangular tear in supraspinatus tendon; bursa not open. Good approximation secured. Result: Good.

Case 12.—J. K., male, 42. Thrown from auto. Dislocation shoulder and fracture greater tuberosity. Treated by reduction of dislocation and physiotherapy to the shoulder.

Loss of abduction; not much pain; no crepitus in passive abduction. Operation seven weeks later. Operative Findings: Bursa scarred and adherent to tendons; old triangular tear (small), either incomplete or, more likely, filled in with scar. Result: Poor.

COMMENT.—While we are inclined to be cautious in attempting to draw definite conclusions from this small series of cases, the following points seem worthy of emphasis:

(1) Complete tear of the supraspinatus tendon is apparently possible without producing a rent in the floor of the bursa. Case 4 illustrates this well. The tear was one and one-half inches long and situated about three-quarters of an inch from the tuberosity and involved the supraspinatus and infraspinatus tendons to an equal degree. While the edges of the tear were not widely separated with the patient relaxed under anesthesia, the tear was complete and involved the capsule as well. Yet the overlying bursa was intact, although the floor was quite hemorrhagic. In view of the foregoing, it appears that an exploration is not complete unless the floor of the bursa is incised and the tendon visualized.

(2) Five of our operated cases were the result of shoulder dislocation. It may be concluded that the belief expressed in certain text-books that the subscapularis is occasionally torn but that other tendons are rarely ruptured, is open to question. Certainly the practice of testing all patients with dislocated shoulders for the ability to actively abduct immediately after reduction is effected is desirable.

(3) The presence of constitutional disease (lues or diabetes) in two of our cases is interesting and suggests that systemic disease may be a predisposing factor in supraspinatus tendon tears.

(4) The presence of the degenerative changes in the torn tendon noted in Case 9 may bear out Codman's belief that the calcification found in so called subacromial bursitis with calcified deposits in the tendon represents slight supraspinatus tendon tears which nature attempts to repair. The alternative conclusion is that the deposit preceded and predisposed to the tear. Against this latter is the fact that the patient previously had had no complaint referable to the shoulder. Furthermore, the yellowish material was not the usual cheesy or (in older cases) tartar-like substance ordinarily found in instances of bursitis, since tendinous fibers could still be identified in the substance.

(5) While the average age of our patients was 50 years, Case 5 was a robust miner of 32. Thus, the diagnosis cannot be absolutely ruled out on the basis of youth.

SUMMARY

- (1) Rupture of the supraspinatus tendon is a common lesion.
- (2) It occurs most frequently in laboring men over 40.
- (3) The lesion presents a characteristic history with well defined physical findings.

(4) Continued shoulder disability following any trauma should be considered a general indication of rupture.

(5) Complete separation of the tendon demands surgical repair.

REFERENCES

- ¹ Codman, E. A.: The Shoulder. Boston, Mass., Thomas Todd Company, 1934.
- ² Keyes, E. L.: Observations on Rupture of the Supraspinatus Tendon. *ANNALS OF SURGERY*, 97, 849, June, 1933.
- ³ Wilson, P. D.: Complete Rupture of the Supraspinatus Tendon. *J.A.M.A.*, 433, February 7, 1931.
- ⁴ Codman, E. A., and Akerson, I. B.: The Pathology Associated with Rupture of the Supraspinatus Tendon. *ANNALS OF SURGERY*, 93, 348, January, 1931.

DUPUYTREN'S CONTRACTURE *

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ALTHOUGH the literature is voluminous, our knowledge of the etiology and the cure of Dupuytren's contracture has not been particularly advanced during the past 20 years. Eighteen years ago the author¹ read a paper on this subject before the Philadelphia Academy of Surgery. To this paper but little can be added today.

Etiology.—The etiology may be considered with reference to exogenous factors, or trauma, and endogenous factors, or the very numerous conditions or agents which produce biochemical changes in the palmar fascia, or to a combination of these two groups of factors.

It cannot be denied that in a small group of cases there is a hereditary tendency to Dupuytren's contracture. Many authors have spoken of it; one cites an instance of 17 cases in 53 members of one family during a period of three generations. The author has a patient with bilateral Dupuytren's contracture whose two brothers, and a grandmother, two aunts and one cousin on his father's side have the same condition. These facts, of course, do not explain the etiology. They simply point to some unknown hereditary, constitutional factor as the cause and demonstrate the irrelevance of trauma as the chief factor.

Trauma, acute or chronic, cannot be considered as a prime factor but only as a possible contributing or exciting cause of fibrositis of the palmar fascia. One author found this condition in only four of 21,800 manual laborers, another in only five of 2,000 industrial workers. Meyerding, of the Mayo Clinic, in reporting Dupuytren's contracture in 273 patients found 45 per cent occurred in farmers and laborers, and 55 per cent in mental workers. These figures would have a definite meaning only if we knew the relative number of manual and mental workers treated at the Mayo Clinic as a whole. In his cases the contracture was bilateral in 64 per cent. Of the unilateral cases 70 per cent occurred in the right hand. The average age of his patients was 54, the youngest 17 and the oldest 80.

We may conclude in part with Davis and Finesilver that trauma is not a prime factor because:

(1) The onset is usually after middle life, even in individuals who have been doing hard manual labor from their youth up.

(2) It is by no means confined to manual laborers and is comparatively uncommon in them.

(3) It is more often bilateral than unilateral. In the use of tools and

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implements there is usually more pressure and strain placed on the palm of one hand than upon the other.

(4) The ulnar portion of the palmar fascia is most commonly affected, while it is at least doubtful if this portion of the palm is more subjected to injury than the remaining portion.

(5) Trauma to the hand, both acute and chronic, is common, while Dupuytren's contracture is rare.

Yet it must be borne in mind that trauma may be an inciting or contributing factor in Dupuytren's contracture in certain cases, as it undoubtedly is in some cases of acute and chronic arthritis, myositis and fibrositis in other parts of the body.

We are reduced to the conclusion that Dupuytren's contracture is essentially of endogenous origin. Some change occurs in the metabolic or biochemical processes taking place in the palmar fascia which produces an inflammatory reaction with the consequent production of scar tissue. This reaction may be acute and manifested by fairly rapid swelling, redness, tenderness and pain on function. The author has observed this in his own left hand and has seen it in other persons. Usually, however, the inflammation is chronic and insidious, although there are often alternating periods of exacerbation and remission.

There are many etiologic factors in the production of chronic inflammations in various parts of the body. They are often more active with the degenerative processes that accompany advancing age. Dupuytren's contracture bears an interesting resemblance to chronic arthritis although it has no direct relation to diseases of joints. One observer found arthritis present in only 10 per cent of 40 cases of Dupuytren's contracture. The factors which cause the arthritides are numerous and they cannot always be determined in every case. But we have come more and more to the realization that many conditions which produce a disturbance of the normal metabolism of the body may cause arthritis. Of these conditions, focal infections occupy a prominent but not an exclusive place. The author has seen cases of Dupuytren's contracture which appeared to be directly connected in their origin and their clinical course with focal infections. One patient had a chronic suppurating osteomyelitis of the jaw. During this period he developed an acute arthritis of one ankle and about the same time a beginning Dupuytren's contracture of the right hand. In two patients with subacute palmar fibrositis the condition improved markedly after the extraction of dead teeth which had apical abscesses in whom no exacerbation or extension of the disease occurred subsequently. Meyerding reports the presence of focal infections in 141 of his 273 cases. One author found Dupuytren's contracture occurred more frequently in diabetes than in any other constitutional disease. Pemberton, as is well known, has found disorders of sugar metabolism in many cases of arthritis.

Dupuytren's contracture has been noted frequently in cases of syringomyelia and has been ascribed to a trophoneurotic lesion. One author believes that

Dupuytren's contracture is the result of a funiculitis or a neurodocitis of the extrameningeal tract of the sympathetic nerve between the ganglion and the plexus. The cause of this condition is a cervical arthritis. He believes that it is a trophoneurotic lesion, but not necessarily of rheumatic origin. It is known that in arthritis there is marked disturbance of the circulation about the joint which may be a primary vasomotor disturbance and not merely a condition secondary to the arthritis.

Hale Powers, a neurologist, has reported 29 cases which he discovered with few exceptions in making neuropsychiatric examinations for the U. S. Veterans' Administration. Many of these were cases of neurosis. Many had been gassed. A number of them had pulmonary tuberculosis. He came to the conclusion that Dupuytren's contracture is due to an overexcitation or hyperactivity of the sympathetic ganglia. This results in atrophic disturbances at the periphery. Some of the cases of Dupuytren's contracture were associated with hypertrophic osteo-arthritis of the fingers, scleroderma and multiple chondromata. He ascribes all of these peripheral manifestations to the one cause and believes that in his cases the sympathetic hyperactivity could be ascribed to upper pulmonary disease. He agrees with Janssen that Dupuytren's contracture is not inflammatory in its pathology but is a hyperplasia of the connective tissue of the palmar fascia. This view of the pathology is contrary to the usually accepted opinion of its being a chronic inflammatory process. I have seen cases which presented the ordinary signs of inflammation such as a fairly acute onset, swelling, tenderness and redness of the overlying skin. Furthermore, hyperplastic normal fascia should show no tendency to contraction such as is found in Dupuytren's contracture.

We may possibly grant the opinion that visceral disease is an etiologic factor in a certain group of cases such as those observed by Powers, but certainly we see many cases of Dupuytren's contracture in which there is no evidence of such visceral disease.

Fibrositis is one of the elements in the pathology of chronic arthritis. Arthritis and Dupuytren's contracture are not infrequently found together in the same individual, and it is possible that the coincidence would be higher in the statistics had all patients with Dupuytren's contracture been examined carefully for arthritis, however incipient and mild. Does it not seem possible that the same causes which cause fibrositis about a joint or in fascia of the back or in bursae may cause a fibrositis of the palmar fascia which is a very active structure of the hand and is subject to the wear and tear of almost constant use and which is subject to the degenerative processes of old age?

How the various etiologic factors produce the pathologic changes which occur in chronic arthritis we are not certain. There is some reason to believe that the changes occur in the structures in and about the joint because of primary disturbance of the blood supply. It may be possible that this primary disturbance occurs through the vasomotor system.

It is interesting to quote from my former paper on this subject an opinion of Kenneth Black² that he believes that: "It, Dupuytren's contracture, will eventually be recognized to be due to a certain internal condition (possibly akin to gout or rheumatism) among persons of advancing years."

The many observations made by various writers on the etiology of Dupuytren's contracture during recent years, only a few of which I have touched upon, should lead us to take a broad point of view as to the origin of this condition. It is probably not an entity in itself. It is more probably due to one or more of many constitutional conditions. Local traumatism, if it has any influence, plays but a secondary part as an inciting or inducing factor.

Treatment.—Excision of the palmar fascia offers the only means of complete cure, but a number of considerations should determine our judgment as to the necessity or the time for operation. The author very decidedly disagrees with Meyerding's dictum that all cases should be operated upon and the earlier the better. The method of operation which offers the best chance for a successful result must also be determined.

Dupuytren's contracture passes through a series of stages during its course of development. The ulnar portion of the fascia is first affected, most commonly that portion which extends to the fourth digit. It may begin acutely as mentioned in the first part of this paper, or may develop very slowly and escape particular attention for a long period. There is no contracture of the fingers and not the slightest interference with the function of the hand during this stage. Some cases never progress beyond this point. The patient should be treated by eradication of focal infections and the correction of any constitutional disorder which might have any possible bearing on the metabolic processes of the body. In a general way he should be treated in much the same way as you would treat a case of incipient arthritis by searching for the possible etiologic factors and by removing them. Operation is contraindicated for the following reasons: (1) The function of the hand has not been impaired. (2) The contracture may never progress. It may even regress if you can remove the constitutional causes. (3) If the case is a progressive one, the fibrosis may extend after operation to other parts of the fascia unless you excise the entire palmar fascia, including its extensions as far as the second phalanges of all the fingers. Indeed, the progress of the case may be accelerated by the traumatism of the operation. The author operated upon a case, in 1923, by excising the entire fascia from the little finger over to and including the index finger. To his dismay the patient rapidly developed a fibrosis of the entire hand with a resulting permanent partial ankylosis of all the joints of the fingers and thumb and of the wrist, and was accompanied by a marked thickening of the palmaris longus tendon above the wrist. He had failed to investigate etiologic factors before operating. The patient had had an abscessed tooth extracted several weeks before operation. A later examination of the tonsils

revealed that both of them retained in their crypts a very large quantity of cheesy, purulent secretion.

During the second stage of this disease the fibrosis extends toward the radial side of the hand and toward the fingers. There may be a beginning contracture of the fourth finger, then of the fifth, and even of the third. Here also the condition may become stationary and may not impair the function of the hand. Within the past year a dentist came to me from another city, having made all preparations to remain for operation. He had a Dupuytren's contracture of six years' duration. It involved the fascia of the fourth and fifth fingers but without contracture of the fingers. His tonsils and one devitalized tooth had been removed a year ago. He had observed no progress of the condition for the past year. It did not in the slightest degree interfere with his work as a dentist. I told him I should not operate upon him. A look of amazement and of pleasure spread over his face. He said, "I am going over to New York and have a good time. I haven't had a vacation in 20 years." I advised him as to a careful search for focal infections, told him to return if the condition should progress and become annoying, and sent him on his way rejoicing.

In the third stage there is marked contracture of one or more fingers and the function of the hand is seriously impaired. Operation should be recommended; but, again, only after careful search for the etiologic factors and after their removal if possible.

The author employs the operation he recommended 18 years ago, a complete excision of the fascia through an incision in the distal palmar crease and through the creases at the base of the finger and at the proximal interphalangeal joint if it is necessary to excise the digital extensions of the palmar fascia. At that time he employed and advised the transplantation of a small piece of fat, from the abdomen or thigh, beneath the skin of the palm. In his operations during recent years he has omitted from the procedure the transplantation of fat and is at present undecided as to its value. But the use of an incision along the line of a natural crease rather than counter to it requires no argument. Various surgeons who have reported cases operated upon by flap incision or by vertical, elliptical, oval or semioval incisions have had some cases of sloughing of skin which required skin grafting later. The author has never had this accident occur following the transverse incisions along the creases of the hand and the fingers. Dissection of the skin from the underlying fascia without making button holes is probably more difficult than through other incisions, but it can always be accomplished by exercising due care and patience. It is never necessary, even in the severe cases, to excise a portion of the skin of the palm and replace it with a graft.

The operation is performed most easily by using a tourniquet about the arm and under general anesthesia. The incisions are closed with interrupted silk sutures. The hand, with the fingers extended, is dressed on a well padded palmar splint until the wounds are healed. Baking and massage

of the hand and fingers are begun after two weeks if there is any indication for their use.

REFERENCES

- ¹ Gill, A. Bruce: Dupuytren's Contracture, with a Description of a Method of Operation. *ANNALS OF SURGERY*, 70, 221, August, 1919.
² Black, Kenneth: *Brit. Med. Jour.*, 50, 326, 1915.

DISCUSSION.—DR. JOHN HOMANS (Boston) noticed that Doctor Gill had said nothing about this disease occurring in women. However, they are subject to it, though in very much smaller numbers than men, just as they do not suffer as much as men from circulatory diseases in the extremities. As to the treatment of this condition, Doctor Gill had not considered roentgen therapy. He knew of one patient who has an incipient disease of this sort, who finds that if he has a moderate exposure the condition improves. He was especially interested in the effect of early operation and thought Doctor Gill's argument very strong. In the face of a disease whose etiology is so poorly understood his theory was certainly very sound. He had had an adventure with one case—it may or may not have been Dupuytren's contracture—but the patient had a contracture of the palmar fascia leading to the little finger. He did not recall that it showed any inflammation. The fascia was dissected out without any particular difficulty and the only thing noticed was that it was unusually adherent to the underlying tissues. After the operation the hand was placed in a splint; the finger at first remained straight, but as soon as the splint was removed it turned right up. The newly formed scar tissue seemed actually thicker than the original and he felt that the operation had done more harm than good. The patient sued him. At the time, however, thinking that he had done the right thing, he defended himself very vigorously.

As to the use of fat: He used a couple of fat transplants and found it difficult to secure healing without more induration and thickening and felt it to be undesirable. The cases were no worse off but they were certainly no better.

DR. A. BRUCE GILL in closing stated that he had not discussed any methods of treatment except excision of the palmar fascia. Multiple incision of the fascia (fasciotomy) with subsequent splinting of the hand as devised by Adams and employed generally for years was ineffective in securing a complete or a permanent cure and frequently resulted in marked fibrous ankylosis of numerous joints of the hand and fingers. Doubtless many of these patients had a chronic arthritis of these joints. Roentgen therapy, injections of fibrolysin and other conservative methods of treatment likewise cannot be relied upon to improve or remove the deformity. Excision of the palmar fascia was the only method of cure.

GLOMUS TUMOR

GLOMANGIOMA

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DURING the past decade there have appeared in the literature case reports of patients who had suffered for years from a painful nodule somewhere about the body, most frequently about the upper extremity, who had been cured by its removal. The histogenesis of these tumors was easily established and, because its origin was traced to the subcutaneous glomus, it was named glomus tumor, or better, glomangioma, as suggested by Bailey.¹

While the histologic structure of this growth is now well known, its clinical behavior and course are not fully established. A characteristic clinical picture and the typical pathologic findings observed recently in a case of glomangioma of a finger justify its report here. Sweating of the finger appearing upon irritation of the nodule adds to our knowledge of the physiology of sweating.

Case Report.—A female, white, age 22, commenced feeling a pain over the palmar aspect of the distal phalanx of the right middle finger. At first the pain was mild and she felt it only on hitting the piano key while playing. Later on the pain became much more severe and appeared on the slightest provocation. Mere touch of the finger tip, pressure on the nail of the finger, or a sudden change of the temperature ushered in an episode of pain. These seizures consisted of three phases: a preliminary slight pain followed at once by the appearance of beads of perspiration over the palmar aspect of the terminal phalanx of the finger, followed by a sharp, burning, stabbing pain referred to the finger tip, which radiated rapidly through the ulnar half of the hand, forearm and arm to the precordium. This produced a sensation of "pulling" in the finger that was followed by a tired feeling in the right hand. The pain would then suddenly disappear and after a few seconds be succeeded by a new attack, of much lesser intensity. Thus, the episodes would gradually wear away leaving the patient exhausted. If the provoking stimulus was very severe the attacks that followed were correspondingly more severe, greater in number and more rapid in sequence. The terminal phalanx of the middle finger remained normal in all respects with the exception of having a much softer skin, as a result of habitual guarding of the finger against contact with any object. The patient's condition was not recognized for years and she was frequently considered a psychoneurotic.

Examination.—First examined by the author ten years after the onset of the pain. On inspection, there was nothing abnormal about the right hand. However, slight pressure with the tip of a lead pencil over one point on the palmar side of the finger tip provoked an attack, followed by the many subsequent subjective sensations as previously outlined. Objectively one saw the appearance of fine beads of perspiration over the palmar aspect of the terminal phalanx. These appeared five to six seconds after the pressure of the pencil. This pressure point was about 1 cm. from the finger end and 0.25 cm. laterally from the midline of the palmar side; pressure on points even only 0.25 cm. away provoked no attack.

Operation.—Under block anesthesia with novocain, a flap of the palmar skin and

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GLOMUS TUMOR

subcutaneous tissue of the terminal phalanx of the finger was turned up. A dark bluish, spongy nodule was discovered at the pressure point described above. This nodule measured 0.2x0.3 cm. but rapidly increased to twice this size when it was touched with a forceps. Two thin thread-like blood vessels were attached to the nodule, one at each end of it. The growth was just beneath the subcutaneous tissue, between it and the underlying bone. It was there unattached to the neighboring structures and it shelled out easily from its niche-like resting place. The skin flap was sutured back in place. The wound healed readily and there was no disturbance of sensation or disfigurement of the finger tip. One month after the operation the patient was able to play the piano freely for the first time in years.

Pathologic Examination.—The nodule presented a ball of contorted blood vessels, resembling in their structure the vessels of the cutaneous glomus (Fig. 1). Some vessels were surrounded by a layer or two of smooth muscle fibers, with a fine collagenous membrane intervening between them and the endothelial lining of the vessels (Fig. 2). Hugging the muscle fibers were groups of large cells with a scanty cytoplasm and densely staining nuclei. About them were seen abundant endothelial cells with pale large vesicular nuclei and deeply staining nucleoli. These polygonal cells are the characteristic glomus cells. Other vessels lack the smooth muscle fibers but are densely surrounded by glomus cells (Fig. 3). The glomus cells are in intimate contact with numerous nonmyelinated nerve fibrils which are easily traced to the larger periglomic fibers. The entire mass of contorted vessels is enveloped by dense collagen fibers, which, broadly taken, might be considered a capsule of the nodule.

One of the two blood vessels attached to the poles of the nodule presented a normal histologic structure of an artery, while the other appeared as a vein. Thus, the nodule strikingly resembled the anastomotic unit of a peripheral arteriovenous anastomosis. We have here the afferent artery, the contorted Sucquet-Hoyer canal, with the neuroreticular and vascular structures about it, and the collecting vein.

COMMENT.—While this condition has been known for centuries, the lesion has attracted a great deal of attention only of late. Because of its rarity, most recent reports in the literature are based upon groups of cases assembled from clinical records that were prepared long before the true nature of the lesion was known. Thus, while the excellent histologic reports are based upon recent studies of the available tissue material, the quoted old clinical reports are not complete and are at times inaccurate and misleading.

A generally accepted error is the description of the lesion as a "purplish-blue discoloration of the skin, mounted on top of a small cutaneous elevation."^{1,2} The fact that the condition frequently remains unrecognized for years proves the fallacy of this description. In the present case there was neither a discoloration of the skin nor any palpable or visible elevation or dimpling of it. This error is based upon a faulty presumption that the nodule is always situated "subepidermally," as stated by Stout.³ Originating from the subcutaneous glomus, situated in the reticular area of the skin, this overgrowth may expand toward the epidermis, and become visible by its discoloration of the overlying skin, or it may extend beneath the subcutaneous tissue, as in the present case, without any discoloration of the skin.

The present knowledge of the nature of the lesion suggests the proper surgical approach to it, especially when it is situated about the finger tip—its most frequent site. The approach must be one that will expose the nodule and at the same time will not disfigure the finger or interfere with

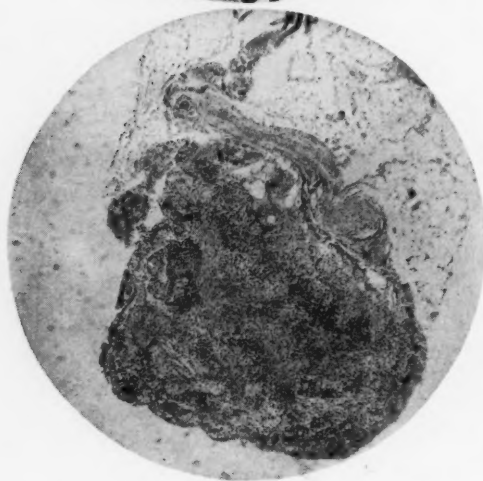


FIG. 1.—Photomicrograph of a cross-section of the glomangioma. The afferent artery, a nerve trunk and a section of subcutaneous fat tissue are seen attached to one end of the nodule (low power).

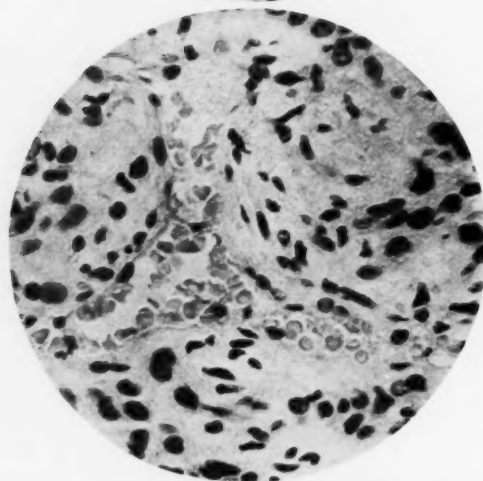


FIG. 2.—Photomicrograph of a vessel in the glomangioma. It is surrounded by a few muscle fibers and numerous epithelioid cells (high power).

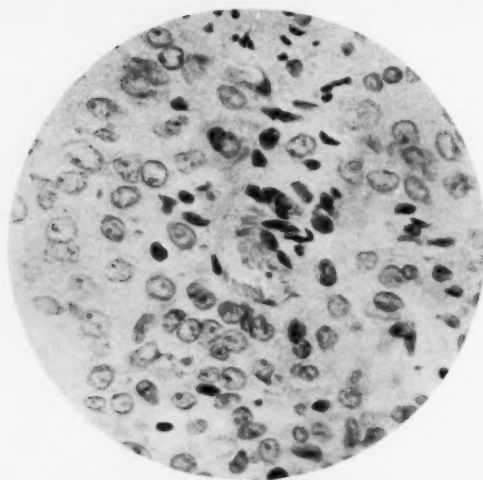


FIG. 3.—Photomicrograph of a vessel showing the absence of muscle fibers; the glomus cells are hugging the endothelium of the vessel (high power).

its sensation. Such an approach is the one used in this case. It obviates failure to locate the lesion and the necessity of repeated operations, as observed in Cases 1 and 4 of the group reported by Lewis and Geschickter.⁴

Since a glomangioma is merely an organoid overgrowth of the normal cutaneous glomus, retaining its physiologic functions, the appearance of beads of sweat on the terminal phalanx of the finger during a paroxysm of pain is of physiologic importance. Our present conception of the physiology of sweating is crowded with numerous hypotheses. Dieden⁵ and others believe in a central nervous system control of sweating, with special stimulating and inhibitory nerve fibers supplying the sweat glands. In support of this view the observation of Rowntree and Adson is quoted that after sympathectomy and ganglionectomy, sweating is abolished. Adamkewich⁶ goes even further. In addition to a spinal cord sweat center he accepts a reflex path by way of the spinal cord to the brain. Thus he explains the known observation of bilateral sweating of the hands following unilateral irritation of the skin. In general, it is considered that sweating cannot occur without the necessary nerve stimulus, and that the sweat glands are not subject to direct stimulation.

One could with difficulty account for the sweating in the present case as a result of a sensory reflex (pain—spinal cord—sweat glands), since sweating was limited to the terminal phalanx, while the provoked pain extended all along the extremity. The marked dilatation of the component blood vessels of the glomangioma upon irritation, as observed during the operation, led to a pathologic exaggeration of the physiologic function of the cutaneous glomus. This function is the regulation of the general temperature of the body; when fully opened the cutaneous glomus aids the dispersal of heat by allowing an increased flow of blood to pass through it. But in a local pathologic exaggeration of this function, as in a glomangioma, this dilatation induces local sweating as an additional means to achieve a dispersal of heat. It seems, therefore, that the general tendency to place the sweat glands under the sole control of the central nervous system is too narrow, and some autonomy must be granted the sweat glands in their function.

REFERENCES

- ¹ Bailey, O. T.: Cutaneous Glomus and Its Tumors. *Am. J. Path.*, **11**, 915, November, 1935.
- ² Jirka, E. J., and Scuderi, C. S.: Glomus Tumor. *J.A.M.A.*, **107**, 201, July 18, 1936.
- ³ Stout, A. P.: Tumors of the Neuromyo-Arterial Glomus. *Am. J. Cancer*, **24**, 255, June, 1935.
- ⁴ Lewis, Dean, and Geschickter, C. F.: Glomus Tumor. *J.A.M.A.*, **105**, 775, September 5, 1935.
- ⁵ Dieden: Klinische und experimentelle Studien über die Innervation der Schweissdrüsen. *Deutsch. Arch. klin. Med.*, **117**, 180, 1915.
- ⁶ Adamkewich: Die Sekretion des Schweißes. Berlin, Hirschwald, 1878.

INTERNAL FIXATION FOR RECENT FRACTURES OF THE NECK OF THE FEMUR *

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A FRACTURE of the hip is often the death blow of the elderly patient. Fractures involving the trochanter unite readily, although deformity and shortening are common, whereas fractures of the femoral neck are notorious for their failure to unite. It is the latter group that I shall discuss in this paper.

The average mortality rate among patients admitted to hospitals for treatment of fractures of the neck of the femur is about 15 per cent. The rate runs higher in some of the hospitals where the derelicts of the large cities are cared for, and most probably in the sparsely settled sections of our country where hospital facilities are not available.

If patients who have fractures of the neck of the femur can be assured of a better chance of a good result by operative treatment, with no greater mortality risk, they should be operated upon. In our experience at The Mayo Clinic the operative treatment carries no higher mortality rate than treatment by nonoperative, conservative measures, provided the operation is performed ten days or more after the injury. Most of the deaths incident to fracture of the neck of the femur occur in the first week or ten days. If the patient survives that dangerous period, the treatment, either conservative or operative, can be undertaken with comparative safety. Immediately following the accident a Thomas extension splint or simple Buck's extension traction may be used to steady the leg and ease the pain. Some patients, manifestly, can stand no real treatment and the life of the weak, debilitated, elderly individual simply ebbs away.

There is no need for haste in reducing the fracture for one can safely observe the patient for from ten days to three weeks before reduction of the fracture is undertaken, provided traction is maintained, with no appreciable disadvantage accruing. Pain can be controlled by the traction and by administration of opiates. If the Whitman method of treatment is used, the patient faces three months of fixation in a plaster spica cast. Operative treatment, with internal fixation by metal, has the very decided advantage that the plaster spica either can be dispensed with entirely or worn for only a few weeks and then movement instituted.

In The Mayo Clinic we have obtained in the past, by the Whitman method, approximately 65 per cent bony unions in those cases in which patients were

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less than 60 years of age and about 54 per cent bony unions in those cases in which patients were more than 60 years of age. Three months or more of confinement in a plaster spica, and the sequelae of stiff knees and hips, is a hardship and ordeal for patients and all others concerned. The method of fixation by use of a nail, reported by Smith-Petersen⁹ in 1931, not only gives a higher percentage of bony unions but convalescence is easier and shorter. Since 1933, we have used either the Smith-Petersen nail or the lag-screw in the treatment of all patients with fresh fracture of the neck of the femur whom we considered presented reasonably good surgical risks.

Operative treatment of fracture of the neck of the femur is not new. It has been urged by various surgeons in the past but Smith-Petersen was the first carefully to report cases. He advocated use of a triple flanged nail and there were included in his report enough records of cases, followed through to completion, to give his report real worth. Following this, various devices for fixation have been advocated, such as cannulated Smith-Petersen nails, wire, pins, screws, screw-bolts, lag-screws and so on. Moore has recently reported a number of cases in which he successfully applied his method of placing three stiff wires at different angles in such a manner that the head was held firmly to the neck of the bone. His method has the advantage that there is very little exposure of tissue and local anesthesia is used.

Internal fixation is not a simple procedure, although it would seem that it should be, after one has accurately reduced a fracture of the neck of the femur, to fix it with a nail, pin or screw. Certain anatomic peculiarities of the neck of the femur explain why this is not easy. The neck of the femur is not more than one inch (2.5 cm.) in diameter; it is placed at an angle with the shaft of approximately 130° and in addition it has an ante-torsion angle of about 15° . These facts, along with a situation wherein the fracture is deeply covered with fat and muscle, and the proximal fragment cannot be grasped, renders the task of nailing a fracture of the neck of the femur anything but simple.

Methods Employed.—It goes without saying that the first essential of any procedure is proper reduction of the fracture (Fig. 1A). To be certain that this is accomplished, anteroposterior roentgenographic views (Fig. 1B) are not sufficient, but lateral roentgenograms must be made also. Lateral views (Figs. 2a and b) are not always easily obtained but the operation should not be attempted unless the surgeon has this information at his command. Taking roentgenograms of fractured hips is not a daily routine in the average hospital; therefore, technicians should practice on normal individuals and perfect themselves in the technic of taking lateral views, so that, when the surgeon is depending so absolutely on the roentgenograms for the success of his operation, they will not be found inexperienced and unprepared.

One method may be called the "open method," in which the fracture is reduced after the hip joint has been laid wide open. Reduction is ac-

complicated under visual control, and the nail, or whatever fixation is used, may also be placed more or less under visual control. Even so, the accuracy of the reduction and the placing of the nail, pins, or screw always should be

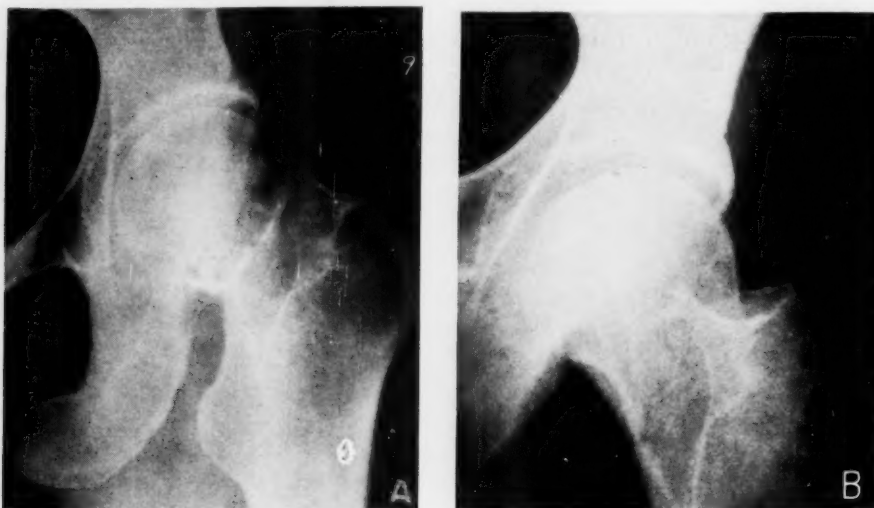


FIG. 1.—(A) Anteroposterior view before reduction. (B) Anteroposterior view after reduction. Note favorable valgoid position of head on neck.

verified by roentgenographic examination before the patient leaves the operating table. Such an operation is a major procedure, entailing a large incision and considerable dissection, with the attendant risk of shock and infection.

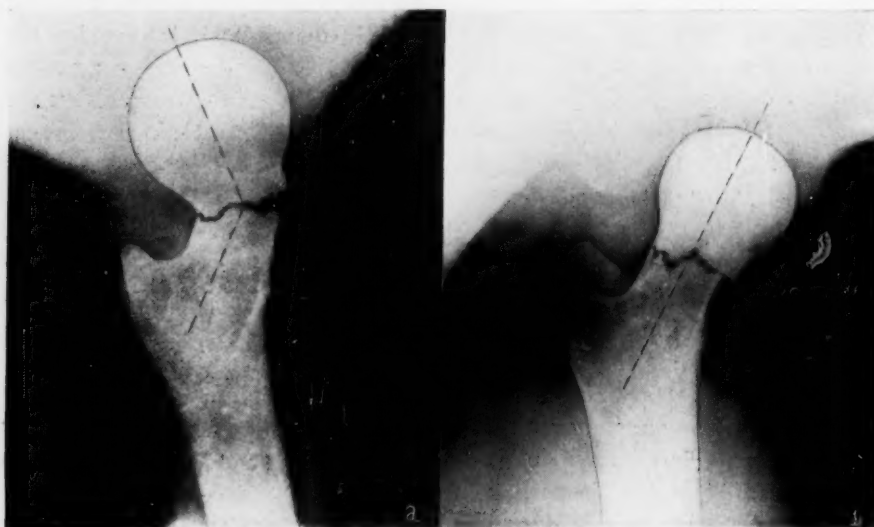


FIG. 2.—(a) Lateral view before reduction. (b) Lateral view after reduction.

However, this method has been practically abandoned and has been replaced by the second method, often erroneously called the "blind" method of insertion of a nail or screw. With proper care as to details such as roent-

genograms at the operating table, calculations as to the angle and depth of insertion of the nail or pins or screw, it is anything but blind in the sense of being uncontrolled.

Guiding Wire for Cannulate Nail or Lag-screw.—Many instruments have been devised to aid in ascertaining the proper angle for insertion of the nail or screw. I have used a number of these instruments but none is sufficiently satisfactory that I am willing to drive the nail in or insert the screw without additional control. It is extremely important that insertion of the nail or screw be accurate for if it has to be withdrawn and inserted again, much damage may be done to the neck and head of the femur; as has been mentioned, the neck is really quite narrow. The placing of a guiding wire under fluoroscopic control or by means of a series of roentgenograms, to insure accuracy, solves the problem.

The idea of a cannulated nail, to be inserted over a thin guiding wire, was developed independently in three places of which I know. Johansson,⁴ of Gothenburg, Sweden, was the first to use such a nail. King,⁵ of Melbourne, Australia, did the same thing as did I¹ at The Mayo Clinic and it has doubtless been done elsewhere also. Definite information as to the position of the guiding wire enables the surgeon to be certain that the line and angle at which he inserts the cannulated nail or screw is accurate, for neither can go wrong on the guiding wire. The length of nail to be used, and how far it is to be inserted, can be determined by measuring the portion of wire that protrudes from the trochanter and subtracting this from the known total length of the wire.

Selection of Cases.—It must be emphasized that if immediate operation for fracture of the hip is performed routinely on a fracture service, an unnecessarily high mortality will result. A number of these patients are definitely senile, have advanced arteriosclerosis and, therefore, present poor surgical risks. On admittance of patients to the hospital a thorough medical examination should be insisted upon. They should be made as comfortable as possible; to this end, as has been stated, extension is used either with or without a Thomas splint. If, after ten days, the patients are in good condition, the relatives may be assured that treatment to secure bony union probably will not entail a mortality risk of more than 3 or 4 per cent, whereas, if such treatment is routinely instituted in cases of fracture of the hip almost as soon as the diagnosis is made, the mortality risk will be nearer 20 per cent. This delay in starting treatment is not necessary if patients are young and robust. It may be that time and experience will prove that immediate internal fixation, accomplished skillfully and quickly, under spinal or local anesthesia, even if the patient is an elderly, weak individual, will save some of them; thus far, however, there is no evidence to that effect. On the contrary, in several localities, where every patient was operated upon at once, regardless of age and condition, the mortality was truly appalling and many deaths that would have occurred anyway were accordingly charged to surgical operation, much to its discredit. The delay

makes no difference in the end-result insofar as obtaining union is concerned; therefore, there is no need for hurry

The type of fracture has a definite bearing on what type of internal fixation should be used. Generally speaking, trochanteric fractures and many of the basilar neck fractures are not suited to the use of either the Smith-Petersen nail or the lag-screw. The amount of bone left in the distal fragment is too small to give adequate fixation to that portion of the nail which lies within it. If the devices just referred to are used under such conditions, full abduction must be maintained. In my experience, the technic of Moore, in which three or four small wires are used, is preferable in these types of cases. Quite often, also, trochanteric fractures are comminuted.

Reduction of the Fracture.—The fracture should be accurately reduced.

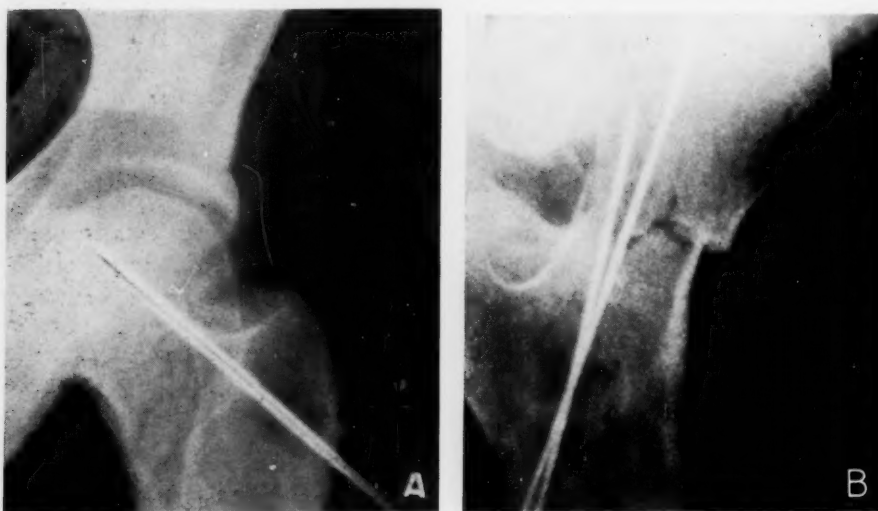


FIG. 3.—(A) Locating wire with guiding wire inserted. Anteroposterior view. (B) Locating wire with guiding wire inserted advantageously into middle of head.

Sometimes this is accomplished merely by traction during the period of waiting. If so, manipulation need not be carried out and some surgeons insert the device for internal fixation with the patient in bed; most surgeons, however, prefer the safety of the operating room. If the fracture is not reduced under traction, manipulative reduction, such as has been described by Leadbetter,⁶ should be carried out and the reduction proved by anteroposterior and lateral roentgenograms.

Technic of Operation.—A convenient cutaneous incision is a diagonal one, running from the vicinity of, and slightly posterior to, the anterior superior iliac spine, downward and backward, just below the trochanter. This makes possible satisfactory exposure of the trochanter and of a portion of the shaft just below it. After careful calculation, based on study of anteroposterior and lateral roentgenograms, a stiff pointed wire is inserted under hand control and lateral and anteroposterior roentgenograms are taken.

FRACTURE OF NECK OF FEMUR

Then, if direction and position are correct, the guiding wire is directed through the lower portion of the trochanter into the neck, into the head, and inserted to a depth of approximately 10 cm. Roentgenograms are taken again, in anteroposterior (Fig. 3A) and lateral directions (Fig. 3B), to determine whether the wire is deep enough in the head and near enough to the middle of the neck and head to warrant inserting the nail or screw. If conditions are satisfactory it is an advantage, after the length of nail that is necessary has been calculated in the manner described, to insert the wire a short distance into the acetabulum, thus helping to steady the head as the nail or screw is inserted. Then the cannulated Smith-Petersen nail or cannulated lag-screw is threaded over the wire and inserted to the proper depth. It is well to verify this final step by another anteroposterior roentgenogram (Fig. 4). The original Smith-Petersen nail has three narrow flanges that are sharp and can be driven in fairly easily. When the nail is made cannulate, the center, where the flanges meet and through which the guiding wire glides, is somewhat thicker than when this nail is not cannulate. This means that more bone must be displaced and pushed aside as the nail is driven in, requiring more force in the hammering. By slipping a small cannulated reamer over the wire a small channel can be prepared in the bone and insertion of the nail or screw can be rendered easier.



FIG. 4.—Lag-screw of duralumin inserted on guide wire by aid of locking bar and placing sleeve.

A point in technic which must be emphasized is the necessity of having the nail deep enough in the proximal fragment (head) so that it gets a good hold, and valgus position of this fragment should be obtained if possible. If the lag-screw is used, care must be taken to see that all of the large threads on the end of the lag-screw are well in the head. If one thread is left in the neck and two threads in the head, manifestly one of the chief advantages of a lag-screw will be lost: namely, its ability to approximate the head and neck.

After the foregoing procedures have been completed, the wound is closed and a single plaster spica applied. This spica is worn for about two weeks.

Lag-screw.—A lag-screw is similar to the screw-bolt described by Henry and has long been used by mechanics to approximate surfaces where it is impossible to use a bolt.

The lag-screw,^{2, 7} modeled to our requirements by Mr. George Little,

chief of the instrument shop at the Clinic, can best be described by referring to the drawing which shows the assemblage in cross-section and end view (Fig. 5). All parts of the assemblage are cannulated by a No. 47 drill. The lag-screw has three large threads, notched to prevent turning of the screw when the placing sleeve is unscrewed. A Kirschner wire is inserted as a guide (Fig. 6a). Previous to insertion of the lag-screw a cannulated reamer is run down over the wire so that the screw will not have too much bone through which to cut (Fig. 6b). The lag-screw is inserted over the guiding wire by aid of the placing sleeve locked into position by means of a locking bar (Fig. 6c). All the large threads must be in the head of the femur and roentgenograms are taken to be certain that the lag-screw is placed at sufficient depth. Next, the locking bar is loosened, removed and

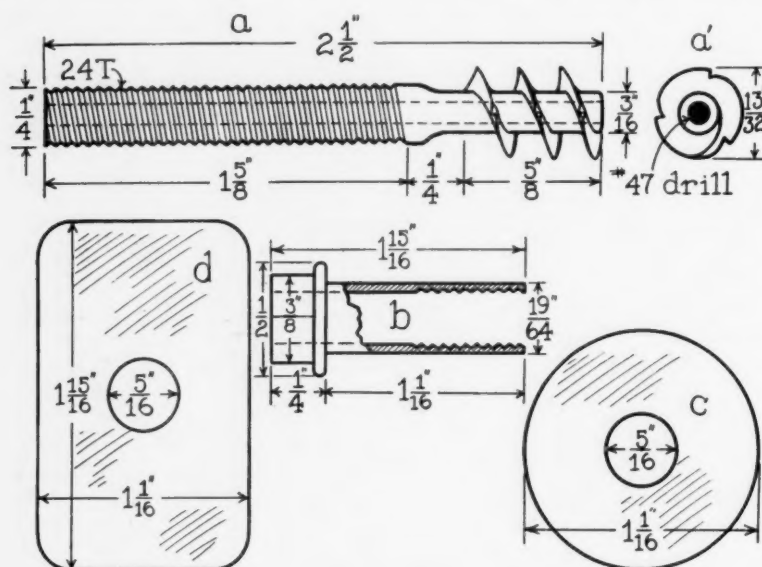


FIG. 5.—Lag-screw assemblage with measurements. The washer to be used beneath the sleeve nut should be of the same material as the lag-screw. (a and a') Lag-screw. (b) Telescoping sleeve nut. (c) Round washer. (d) Larger washer that can be molded.

the placing sleeve is unscrewed and withdrawn. This leaves the lag-screw entirely buried (Fig. 6d) but the guiding wire permits slipping the telescoping sleeve nut (Fig. 6d), on which is a washer, down to the distal end of the lag-screw which is threaded to receive it. The sleeve nut is tightened by aid of a socket wrench until the washer impinges on the trochanter and is molded around it and the sleeve nut further tightened. This draws the fragments together tightly (Fig. 6e). The guiding wire is then removed, the wound closed, and a plaster spica applied.

Monel metal is thought to be a satisfactory material from which to construct the lag-screw, telescoping sleeve nut and washer, but the last word has not been said on this question. All must be made of the same metal or an electrolytic, irritative reaction will be set up and cause a collection of

fluid that on culture is found to be sterile. There may be no evidence of fluid until six or even ten weeks after insertion of the metal. Once present, it persists until the metal is removed. If the effusion is excessive, repeated aspirations may be necessary. I do not know whether the slight movement that occurs between the female portion, that is, the telescoping sleeve nut, and the male portion, that is, the distal, threaded end of the lag-screw, is sufficient to produce the electrolytic reaction. Dentists have long been bothered by electrolytic reactions after the filling and capping of teeth. In those cases in our series in which this sterile fluid did collect, no untoward effect was noted insofar as the end-result was concerned. Lag-screws made of duralumin have caused the least reaction and we intend to use them in the future. They should not be left in place (Fig. 7) longer than six months. Those removed (Fig. 7) have shown distinct evidence of erosion due to tissue reaction and it is conceivable that this may easily become so extensive that the lag-screw would be weakened, the threads destroyed and removal made difficult.

We have not enough cases in which the lag-screw has been used to justify our offering any comparison as to the relative merits of it and of

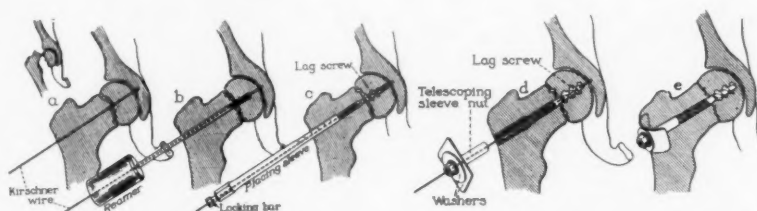


FIG. 6.—(a) Kirschner guide wire in situ. (b) Reamer introduced over the wire to make a channel and prevent binding of the screw on insertion. (c) Lag-screw being inserted by aid of placing sleeve and locking bar. (d) Lag-screw in position; channel in trochanter enlarged to facilitate insertion of sleeve nut. (e) Sleeve nut tightened. The large threads are in the head of the femur only. The Kirschner guide wire has been removed.

the Smith-Petersen nail. They are both forms of metal, internal fixation. The lag-screw has the advantage of approximating the femoral head and neck and can easily be made to fit the individual patient by merely screwing down the telescoping sleeve nut. Its use entails a more complicated procedure than use of the nail and time alone will show whether its apparent and theoretic advantages are borne out in actual practice.

Postoperative Care.—Motion of the hip and knee may be started safely after 14 days. This is best done by aid of a system of overhead suspension, with sling, ropes and pulleys. The patient, by pulling on the rope, flexes the knee, and so the hip, but he must not be permitted to over-do. Flexion of the hip by this passive method to an angle of 45° to 60° is ample. It must be remembered that there is nothing in the internal fixation that will cause bony union to develop more rapidly. It is estimated that even under the best of conditions bony union never occurs in less than 90 days (Fig. 8A). Therefore, weight-bearing in less than that period should not be permitted and a

safe rule is to insist that full weight-bearing be delayed until six months have elapsed (Fig. 8A). It was at first hoped that the size and strength of the Smith-Petersen nail would render possible much earlier weight-bearing but Smith-Petersen himself now warns against this. Internal fixation of these fractures entirely changes the picture of convalescence. Patients are out of bed and soon are getting about on crutches and their whole view of life is much more cheerful than otherwise.

Discussion of Cases in Which Operation Has Been Performed.—This report is based on 14 cases, in 11 of which the patients were women and in three, men. In all, more than one year has elapsed since the operation and the condition of the patient is known. The ages of the patients were as follows: One was between 20 and 30 years of age; one, between 40 and 50; two, between 50 and 60; five, between 60 and 70; four, between 70 and 80; and one, more than 80.



FIG. 7.—Lag-screw assemblage ten weeks after insertion.

Five patients were operated upon more than three years ago; three, more than two years ago; three, more than 18 months ago and three, more than one year ago. There were no deaths attributable to the operation although two patients have died since convalescence. One of these was a woman, more than 80 years of age, who lived for 18 months after insertion of a Smith-Petersen nail and walked comfortably although feebly; she died of the changes of senility. The nail was not removed. The other of these two patients was 70 years of

age and died of a heart attack 16 months after operation. She likewise had solid bony union and the nail was never removed. Both of the two patients who died were of the group of five who were operated upon more than three years ago. The other three patients in this group obtained bony union but one, now age 70, has definite arthritis, with some shrinking and irregularity in the size and shape of the femoral head. The remaining two, both now over 70 years of age, have normal function.

Of the three patients who were operated upon more than two years ago, all have excellent results, with normal function. One was a woman, age 20, injured while horseback riding, one was age 56 and the other, age 72.

Of the three cases in which more than 18 months have elapsed since the operation, one has not done well. She was 70 years old when she was operated upon, and 15 years before she had undergone resection of the

FRACTURE OF NECK OF FEMUR

stomach for carcinoma. We suspected that the fracture of the hip might be attributable to metastasis but it did not appear to be so on careful study; therefore, a Smith-Petersen nail was inserted. A late, slightly purulent drainage of low grade followed; the nail was removed three months after insertion. The drainage has ceased and now, 21 months afterward, I feel certain that the fracture is united. There is poor function, however; the patient is old, frail and weak, and I fear hidden, late metastases, although this cannot be proved. Of these three patients, the other two, one 61 and the other 67 years of age, have, to all intents and purposes, normal function and both have bony union.

Of the three patients who were operated upon more than one year ago, one, a woman, age 76, was treated by means of a cannulate, large-threaded,

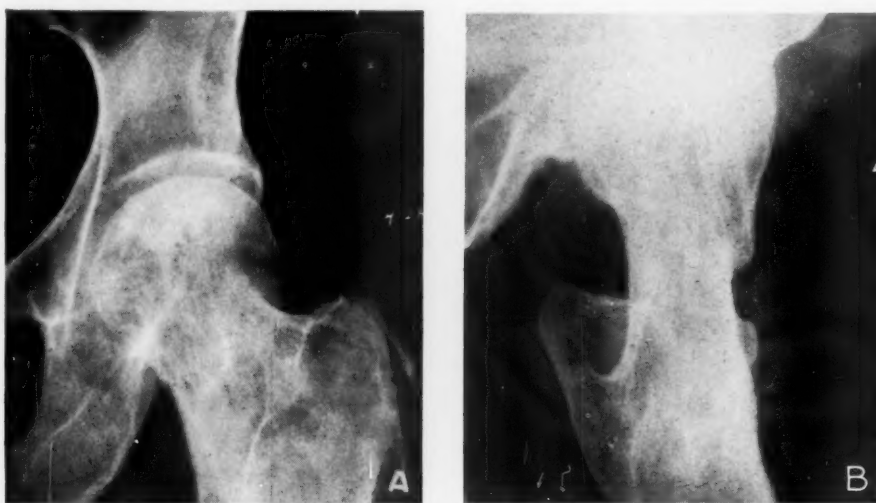


FIG. 8.—(A) Lag-screw removed. Anteroposterior view shows bony union eight months after operation. (B) Same patient as is represented in Fig. 7. Lateral view eight months after operation.

wood screw. It did not hold properly, serous drainage of low grade developed six weeks after operation and the screw was removed after six months. I would put her case down as a failure although I believe that bony union is present. In the two other cases the patients were age 77 and 54, respectively; both have solid bony union with excellent function.

SUMMARY.—Of 14 patients subjected to operation more than one year ago, 12, or 86 per cent, obtained really excellent results; that is, they have bony union with excellent function. One has union in malposition and she is in poor health, so the result cannot be called good. No serious infection occurred; drainage followed late in two cases. There were no deaths from the operation and in all cases convalescence was much more satisfactory than has been our experience in treating fractures of the neck of the femur by the conservative method.

CONCLUSIONS

Internal fixation is a definite step forward in the handling of fractures of the neck of the femur, for it raises appreciably the percentage of unions. The next step is to establish its value in the early restoration of function and whether atrophy of the head follows in its wake more often than occurs following conservative treatment.

REFERENCES

- ¹ Henderson, M. S.: Fractures of the Neck of the Femur, Recent and Old; a Report of 631 Cases. *South. Med. Jour.*, **27**, 1032-1039, December, 1934.
- ² Henderson, M. S.: Discussion. *Proc. Staff Meet. Mayo Clinic*, **11**, 615-618, September 23, 1936.
- ³ Henry, M. O.: Intracapsular Fractures of Hip; New Device for Lateral Osteo-synthesis. *Jour. Bone and Joint Surg.*, **16**, 168-172, January, 1934.
- ⁴ Johansson, Sven: On the Operative Treatment of Medial Fractures of the Neck of the Femur. *Acta Orthopaed. Scandin.*, **3**, 362-392, 1932.
- ⁵ King, Thomas: Recent Intracapsular Fractures of the Neck of the Femur; a Critical Consideration of Their Treatment and a Description of a New Technique. *Med. Jour. Australia*, **1**, 5-15, January 6, 1934.
- ⁶ Leadbetter, G. W.: A Treatment for Fracture of the Neck of the Femur. *Jour. Bone and Joint Surg.*, **31**, 931-940, October, 1933.
- ⁷ Macey, H. B.: Report of the Fracture Service for 1935. *Proc. Staff Meet. Mayo Clinic*, **11**, 613-614, September 23, 1936.
- ⁸ Moore, A. T.: Fracture of the Hip Joint; Treatment by Extra-articular Fixation with Adjustable Nails. *Surg., Gynec. & Obstet.*, **64**, 420-436, February 15, 1937.
- ⁹ Smith-Petersen, M. N., Cave, E. F., and Vangorder, G. W.: Intracapsular Fractures of the Neck of the Femur; Treatment by Internal Fixation. *Arch. Surg.*, **23**, 715-759, November, 1931.

BRIEF COMMUNICATIONS AND CASE REPORTS

A METHOD OF REDUCING LARGE DIAPHRAGMATIC HERNIA FROM ABOVE

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THERE has been divergence of opinion over the best surgical approach for the repair of diaphragmatic hernia. Some advocate an abdominal incision. Others open both the chest and abdomen. In the combined approach reduction is made easier by traction from below on the herniated viscera.

We agree that parasternal herniae are best approached through the abdomen. This type may invade either pleural cavity or both at the same time. If the hernia invades both pleural cavities (a difficult preoperative diagnosis) then there is less chance of causing a bilateral pneumothorax in using the abdominal approach, and both sides may be repaired at the same sitting. We are suggesting a method by which the reduction of all other herniae can be readily accomplished through the chest wall. Any adherence of the herniated viscera to the structures of the thorax can be dealt with under direct vision. If the herniated viscus is held too snugly by a tight ring, then the rent in the diaphragm can be enlarged at one end. Phrenic nerve damage is to be avoided. In case one finds an obstructed gangrenous intestine in the chest cavity, it will then be necessary to open the abdomen so as to bring the clamped-off bowel out through the abdominal wound. Anastomosis is not practical. It is wise to bear in mind the possibility of an acutely obstructed diaphragmatic hernia when the cause of an intestinal obstruction is unexplained. Its detection will save opening the abdomen when the better approach may be by way of the chest. The history of a severe antecedent trauma to the torso may arouse the suspicion of the correct diagnosis in the examiner's mind. Unequal movement of the costal margins on respiration, a displaced cardiac dullness or abnormal auscultatory findings in the thorax will be an indication for taking a scout film of the chest, which will confirm the diagnosis. The use of contrast media to accentuate the roentgenologic findings is, at such a time, hardly feasible.

Case Report.—A male, age 46, was seen in consultation with Dr. E. R. Brooks, April 1, 1936. The patient had been in an automobile wreck six months before, but did not know what struck him; probably it was the steering wheel, as he was driving. He was unconscious for several minutes following the accident. The right side of his chest and abdomen were lame for the next three weeks. Two months ago he started to have abdominal cramps and an increasingly more marked gurgling in his upper abdomen and

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FIG. 1.

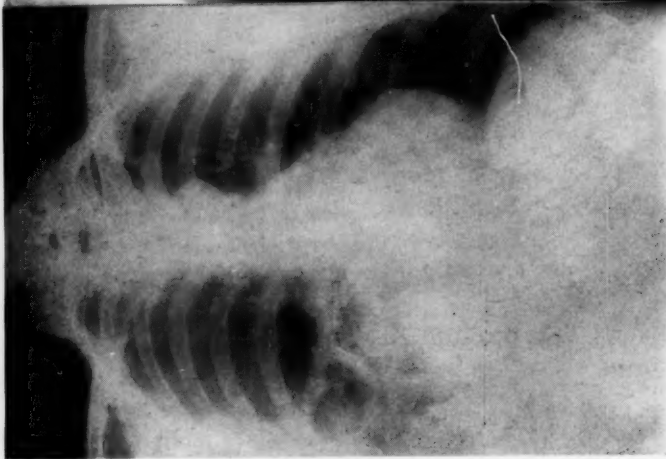


FIG. 2.



FIG. 3.



FIG. 1.—Standing: Roentgenogram showing the herniation of hollow viscera into the right chest cavity. The cardiac end of the stomach is seen to lie under the left diaphragm. The entire body of the stomach is herniated through the right diaphragm. The herniated part shows a marked upward angulation. The pylorus and duodenal bulb are on the right side under the diaphragm. Stomach constricted at the entrance into the chest and at the exit from the hernial opening.

FIG. 2.—Koenigsmethodic examination of colon after barium enema showing the extensive herniation of the right side of the transverse colon. Exit and entrance of herniated loop are indicated by the points of constriction.

REDUCTION OF DIAPHRAGMATIC HERNIAE

right chest. Examination of his chest showed no cardiac displacement but the unequal flare of his costal margins on deep breathing plus the gurgling heard over his right chest on auscultation. On roentgenologic examination, Dr. Eugene Freedman made the fluoroscopic diagnosis of an anterior right-sided diaphragmatic hernia (Figs. 1, 2 and 3).

Operation.—The stomach was washed out, in order to eliminate regurgitation during the manipulations. Anesthesia.—Avertin (60 mg. per kilo) plus nitrous oxide, without intratracheal catheter. The head of the table was raised 20 degrees and the patient placed on his left side, his body rotated in the long axis 30 degrees, so that his right chest was uppermost. The right arm was raised above his head. Block of the seventh, eighth and ninth intercostal spaces, posteriorly, with 10 cc. of 1 per cent novocain solution in each

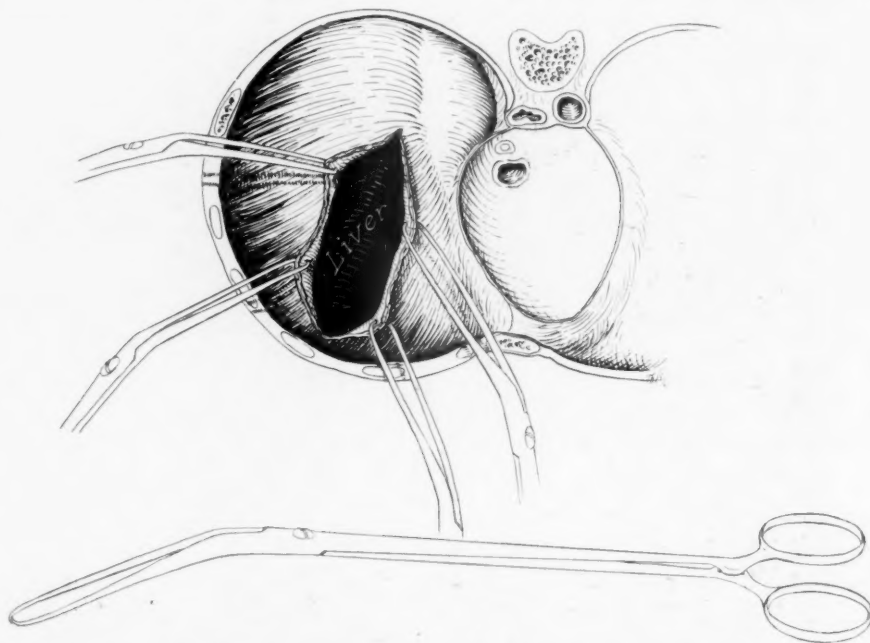


FIG. 4.—Upward traction on the edges of the rent by Lower's hooks as an aid in reducing diaphragmatic hernia via the chest approach.

interspace. Incision, 30 cm. long in the eighth interspace from the posterior axillary line to the midline in front. Intercostal muscles divided and the chest opened widely with a rib spreader. Due to the presence in the chest of the abdominal viscera, there was little change in respiration with the chest open. One saw the retracted lung lying in the upper medial area of the chest.

In the lower chest we found small intestine, colon, stomach and most of the right lobe of the liver. The liver had been rotated on its transverse axis and, as one looked into the chest from the front, the lower liver surface presented, with the fundus of the gallbladder pointing up toward the right shoulder. The liver had been drawn into the chest, from the notch, to the area on its lateral margin which corresponded to the posterior axillary line on the chest wall.

We were able by the sense of touch to hook an index finger beneath the medial edge of the rent in the diaphragm and then catch this edge in front and behind with two Lower angled, bladder hooks. In the intervals of relaxation of the diaphragm that followed each respiratory movement, we reduced the hollow viscera into the abdominal cavity. This gave enough space in the chest so that we could catch the lateral edge of the rent in the diaphragm with two more bladder hooks. The liver was then easily reduced. Upward

traction on the bladder hooks helped greatly in the reduction. One reduces intestines during a celiotomy in the same manner by vertical traction on the wound edges.

Dr. W. E. Lower had adapted these hooks from the ordinary single-toothed cervical volsellum. They are made in pairs—right and left angled—the blades of the forceps are bent 30 degrees laterally, just distal to the lock (Fig. 4). Their use permits upward traction of the wound edges of the diaphragm without having the handles of the instruments get in the operator's way. Their use materially helps in the reduction of the hernial contents in the chest approach. They also are helpful in holding the edges of the rent together while the sutures are being laid for the repair.



FIG. 5.—Appearance of wound ten days after operation.

There was no tendency after reduction for the abdominal contents to reenter the chest as the liver acted as a stopper to hold them in their normal position.

The tear in the diaphragm was clean cut, 15 cm. in length and lay in the axis of seven o'clock—looking from above down. Its origin was at the nipple line, starting 2 cm. from the attachment of the diaphragm to the chest wall, and extended medially and posteriorly into the central tendon. It was closed with silk sutures placed at 5 Mm. intervals. There was no tension on the suture line. Closure of the chest wall with three silver wire sutures which encircled the eighth and ninth ribs. Closure of the intercostal muscles with interrupted silk. Before pulling tight the last muscle suture we asked the anesthetist to expand the lung by increasing the gas pressure and then aspirated the remaining air left in the pleural cavity by catheter suction. Fine silk in the subcutaneous fat, clips in the skin.

During the operation the blood pressure remained around 120/90, pulse 76 to 80. In

order to reduce postoperative retching, we gave nothing by mouth for two days following operation. Continuous intravenous drip was supplied by a cannula in the internal saphenous vein at the ankle for 48 hours. Convalescence was uneventful (Fig. 5). Discharge April 15, 1936.

Fluoroscopic examination and roentgenograms of the stomach and colon, April 14, 1936, showed all the viscera to be back in their normal positions. Both diaphragms moved normally under the fluoroscope.

Follow-up.—September 14, 1936. He had gained ten pounds in weight, and was eating everything without complaint. Both diaphragms move normally.

ACUTE INFLAMMATORY JEJUNITIS WITH INTESTINAL OBSTRUCTION *

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Case Report.—The patient, a male, age 21, presented himself for admission to the Mount Sinai Hospital, with a history of acute abdominal pain and vomiting, which had begun seven hours previously. For a period of two months preceding admission the patient had had peri-umbilical discomfort. He appeared acutely ill, and presented resistance, tenderness, and rebound tenderness in the right lower quadrant of the abdomen. A leukocytosis was present, and a diagnosis of an acute appendicitis was made. He was operated upon (Garlock) through a McBurney incision. The appendix was found to be bound down by a few edematous adhesions. It, however, aside from slight injection, did not show gross evidences of an acute process. Search for a Meckel's diverticulum or terminal ileitis was negative. The abdomen was closed in layers, and an uneventful convalescence ensued.

About a month later the patient was readmitted because of persistent pain and diarrhea, the stools numbering from two to five a day and in some, dark blood was noted. There was no pus or mucus. The pain was quite severe and was frequently accompanied by a desire to defecate. The physical examination, including sigmoidoscopy, was essentially negative. Barium enema was negative. In view of the negative findings it was felt that the patient was suffering from a functional mucous colitis and was discharged to receive country convalescent care and then he admitted to the Mental Health Clinic. About a month later he was again readmitted with a history of recurring generalized abdominal pains which seemed to be more marked after taking food, although they bore no definite relationship to meals. They seemed to be most marked in the left lower quadrant of the abdomen. Bowel movements averaged two a day.

Physical Examination revealed a thin, asthenic, chronically ill young man with general, moderate abdominal distention. There was slight tenderness throughout the abdomen, most marked in the left lower quadrant. No masses could be palpated. During a 48 hour period of observation the patient continued to have increasingly severe cramps and at this time visible peristalsis was noted in the left lower quadrant. He vomited once. A tender mass could be palpated per rectum.

Operation.—Through a four inch left lower rectus incision the peritoneum and omentum were found to be deeply injected. Loops of presenting small intestine were markedly dilated. Palpation revealed a sausage shaped mass occupying an area in the small intestine about one foot in length, located in the distal jejunum. Its proximal end was hard and infiltrated; the distal end was edematous and covered by a shaggy peritoneal exudate. The proximal intestine was hugely dilated, the distal collapsed. A lateral

* Presented before the New York Surgical Society, November 25, 1936. Submitted for publication March 5, 1937.

anastomosis was made between the afferent and efferent loops. The anastomosis was made sufficiently distant from the tumor mass to permit of subsequent resection without disturbing the anastomosis, if this should be found to be necessary. The wound was closed in layers without drainage, and an uneventful postoperative convalescence ensued.

Subsequent Course.—The patient has been seen on numerous occasions, and until recently has appeared to be in the best of health. For the past four or five months, however, there has been some abdominal discomfort, although he has maintained his weight and his bowels have been moving normally. Recent roentgenologic examination of the gastro-intestinal tract reveals several areas of stenosis in the small bowel producing dilatation proximal to them. Some of these loops are markedly dilated and are situated in both the jejunum and ileum.

COLECTOMY FOR CHRONIC ILEOCOLITIS

POSTOPERATIVE INTESTINAL OBSTRUCTION. PERFORATION OF ILEUM BY ENTEROSTOMY TUBE. SUBPHRENIC ABSCESS. RECOVERY

Case Report.—The patient, a male, age 18, was first admitted to the Mount Sinai Hospital in August, 1935, complaining of abdominal cramps which had been present for six weeks, accompanied by some temperature and profuse sweats. There had occurred a similar episode three months before admission. He had had three to four loose brown stools daily during the period of his present complaint. No blood, mucus or pus had been noticed in the evacuations. There was an appreciable loss in weight. The abdominal pain was for the most part confined to the right lower quadrant.

Physical Examination revealed a thin, undernourished, chronically ill young man. Except for the abdomen, where moderate tenderness in the right lower quadrant could be elicited and a thickened area of intestine could be palpated, the physical examination was negative. The stools consistently showed a four plus guaiac. Sigmoidoscopy revealed no abnormality. Gastro-intestinal roentgenologic study showed an irregular stenosis of the terminal ileum with dilatation proximally. In addition, the colon from the cecum to the region of the splenic flexure showed loss of haustrations and marked disturbance in the mucosal pattern, indicative of an ulcerating lesion. Barium enema revealed an irregular stenosing lesion of the entire proximal half of the large bowel.

Operation.—Under general anesthesia, the abdomen was opened through a left, midrectus incision. The terminal ileum, cecum and ascending colon were found thickened and edematous. The sigmoid appeared normal. The terminal ileum was divided one foot proximal to the ileocecal angle and a side-to-side ileosigmoidostomy was performed. A wound infection developed, but otherwise the convalescence was uneventful.

The patient was readmitted one and one-half months later for colectomy. During this time he had gained some weight, but his stools still contained blood and he still continued to have abdominal cramps, although on the whole his condition had improved considerably.

Operation.—Under general anesthesia, the scar resulting from the previous operation was excised, adhesions divided and separated, and the previously effected ileosigmoidostomy identified. The terminal ileum, ascending, transverse and splenic flexures were resected after separating the omentum. The resection extended into the uppermost portion of the descending colon where the bowel appeared healthy. Retroperitoneal spaces were peritonealized. The wound was closed in layers without drainage except for rubber tissue drains placed superficially at either angle.

Pathologic Examination.—*Gross.*—The specimen (Fig. 1) consisted of the terminal 18 cm. of ileum, appendix, and 45 cm. of ascending, transverse, and splenic flexures of the

COLECTOMY FOR ILEOCOLITIS

colon. The mucosa of the proximal portion of the resected ileum was soft, succulent and presented innumerable pinhead-size, delicate pink excrescences. The more distal 5 cm. of the resected ileum was smooth, its mucosal folds completely obscured, the mucosa thickened, and there were many shallow, punched out mucosal defects varying in size from a pinhead to $\frac{1}{2}$ cm. in diameter. The bases of the ulcerations were finely irregular, hemorrhagically discolored. The mucosa about these ulcerated areas was pearl gray with here and there a hemorrhagic, punctate zone. The wall of the ascending colon was slightly thickened, firmer than is usual, the mucosa irregularly mottled, dark red, pink and gray. The basic architecture of the colonic mucosa was completely obliterated. There were noted in the proximal portion of the ascending colon, and

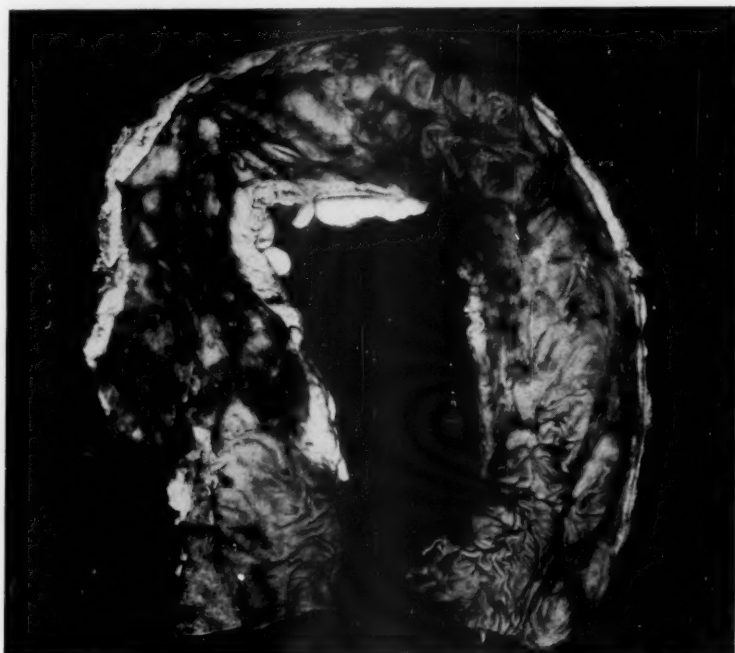


FIG. 1.—Gross specimen of resected terminal ileum, ascending, transverse and splenic flexures of colon for ileocolitis.

more particularly in the cecal area, several shallow, punched out ulcers with hemorrhagic bases. There were many slightly pouting, longitudinal folds, soft in consistency, varying in breadth from $\frac{1}{2}$ to $1\frac{1}{2}$ cm., doughy in consistency and separated, one from the other, by hemorrhagically discolored, craggy, slightly depressed, linear zones. Toward the terminal portion of the specimen it was noted that the pouting linear strands described before represented portions of the normal colonic mucosa which was present at the terminal portion of the resected specimen.

The appendix measured 5 cm. in length and had been previously opened; its mucosa was slightly thickened, succulent, and in its basal portion presented two pinhead-sized punched out, superficially ulcerated areas, the bases of which were pearl gray. The serosal aspect of the specimen presented dull gray, exceedingly fine mammillations.

There were numerous pericolic lymph nodes, oval in shape, varying from $\frac{1}{2}$ to 2 cm. in length and $\frac{1}{2}$ to 1 cm. in breadth. They were rather soft in consistency; their sectioned surfaces moist, their peripheral portion pearl gray, while the central zone was light red.

Microscopic Diagnosis.—Chronic ulcerative colitis involving the terminal ileum.

Postoperative Course.—The patient appeared to be doing very well following this procedure until four days after operation, when he presented classical signs of an intestinal obstruction, which was confirmed by a scout roentgenogram of the abdomen which showed distended small bowel with fluid levels. Celiotomy was performed five days after the colectomy through a right midrectus incision. Numerous distended coils of the small intestine were encountered bound down by recent adhesions. There was a large quantity of free fluid in the abdomen. The intestines were traced down to the region of the ileosigmoidostomy and it seemed that some loops ran under the mesentery of the ileum used in making this anastomosis. It was deemed inadvisable to disturb this mesentery for fear of compromising the blood supply. An enterostomy, using a No. 26 French catheter, according to the method of Witzel, was effected in the most distal, distended loop. The tube was brought out through the lower angle of the incision. Following this procedure the patient did well, the enterostomy functioned excellently, and the patient appeared to be well on the road to recovery, with normal temperature and pulse five days after the second operation. On the sixth day there was a repetition of the entire clinical picture but this time with a rise in temperature, cramps and abdominal tenderness. The enterostomy stopped draining and was irrigated a number of times without success, fluid being readily introduced but with no return. The patient now appeared extremely ill. Roentgenologic examination again supported the diagnosis of an intestinal obstruction, and one week after the previous operation, an incision was made between the two existing scars. The abdominal exploration revealed a diffusing fibrino purulent peritonitis with pus and fibrin binding down loops of gut everywhere, particularly in the upper quadrants. In separating the loops of intestine, a large abscess cavity was encountered in which the proximal two inches of the enterostomy tube were seen emerging through a free perforation in the ileum. The tube was withdrawn and the perforation repaired. The abdomen was closed without drainage. Culture of the pus revealed *B. coli*, enterococci and *Staphylococci aureus*. Following this operation patient was critically ill for a long while, and required a number of transfusions. The wound became severely infected and had to be widely opened. A large quantity of pus was discharged through the upper angle of the incision. It seemed to come from an intra-abdominal collection and was traced to the subphrenic region, being visualized by an injection of lipiodol. A counter incision, for more dependent drainage, was deemed advisable, which was accomplished by excising the tenth rib, in the postaxillary line, and suturing the pleura to the diaphragm. A small rent in the pleura resulted in a pneumothorax. Subsequently, with a probe in the abdominal sinus, the subphrenic abscess was incised. Following this the patient made a gradual but prolonged convalescence, being discharged well, approximately three months after the colectomy.

DISCUSSION.—DR. HENRY W. CAVE (New York) discussed the question of colectomy in reference to chronic ileocolitis. In the last eight months he had performed three colectomies for chronic ulcerative colitis, and emphasized what he considered very important points:

(1) The importance of three preoperative preparations of these patients: (a) Low residue diet. (b) Intravenous fluids. (c) Fluid diet, 24 to 48 hours preceding the operation, and also pills containing lead and opium for 72 hours prior to the operation, as was suggested by Mont Reid in patients suffering with tumors of the large bowel.

(2) Careful selection of cases where colectomy is indicated. Recently he had seen a patient who had chronic ulcerative colitis, and upon whom he expected to effect a terminal ileostomy and possible colectomy, until it was discovered the patient was allergic to pork and milk. He was taken off these two foods for four months, and has shown a remarkable recovery since.

(3) A more thorough side-track of the fecal current can be accomplished by performing an end-to-side ileocolostomy. The Rankin clamp and the Furness clamp are excellent in accomplishing an end-to-side anastomosis. In the great majority of cases of the chronic ulcerative type, such as Doctor Klingenstein cited, it is preferable to effect a permanent terminal ileostomy, and then, if the colectomy is necessary, he has used a long, left paramedian incision; through which it is easier to sever the splenocolic ligament. Transfusion is advocated at the time of the first stage, as well as immediately following the second or third stage procedures. In patients where the ulceration involves the rectum, rubber-guarded clamps are preferable to crushing clamps of any kind, because with an unguarded clamp there is great danger of cutting into the thin friable wall of the bowel with resultant soiling.

DR. RALPH COLP (New York) recalled, relative to Doctor Cave's mention of the fact that the divided sigmoid is rather difficult to close, especially in cases of ulcerative colitis in which the rectum is not particularly involved, that, in 1913, von Beck reported an operation for ulcerative colitis, in which he divided the ileum near the ileocecal junction, and the colon at the sigmoid. The terminal ileum was closed and the proximal loop of colon was brought out as a colostomy, thus isolating the colon. He then recommended the anastomosis of the proximal ileum to the distal segment of the sigmoid by end-to-end suture. Doctor Colp said the teaching in the past had been that intraperitoneal anastomoses are rather dangerous and should be avoided whenever possible. In a recent case, however, he undertook a procedure similar to the von Beck operation, but with modifications. He divided the ileum and brought out the proximal colon as a colostomy, thus isolating the colon. He then brought the proximal ileum out through a left rectus incision as an ileostomy, and the distal portion of the sigmoid out as a sigmoidostomy, approximating the intraperitoneal portion of both loops by interrupted serosal sutures. The sigmoid and rectum are put at rest for a desired period, and, if multiple polypi are present, a sigmoidoscope may be introduced through the rectum or through the sigmoidostomy, and any polypi which may be present may be fulgurated. At some future time, provided the general condition of the patient is satisfactory, the spur between the ileum and sigmoid may be crushed, and an extraperitoneal closure effected. In that way the danger of intraperitoneal leakage is avoided. The isolated colon may then be removed, if necessary.

CHRONIC INFLAMMATORY TUMOR OF THE MESENTERY

Case Report.—The patient, a male, age 50, was first seen by Dr. Maurice Rashaum, who identified a large, lobulated, movable abdominal mass during the course of a routine physical examination. The patient at that time was ignorant of its existence and it had given rise to no abdominal symptoms. He was referred to the Diagnostic Clinic of the Mount Sinai Hospital where complete roentgenologic studies of the gastrointestinal tract were made, but no definite diagnosis was arrived at. There had been some recent weight loss. There was no diarrhea, cramps or constipation.

Physical Examination except for the abdomen was entirely negative. In the right lower quadrant of the abdomen there was a hard nodular mass, nontender and freely movable. In spite of the negative roentgenologic examination, on account of the firmness and nodularity of the mass, a preoperative diagnosis of carcinoma, possibly in a mobile cecum or in a loop of small intestine, was made.

Operation through a five inch, right, midrectus, muscle-splitting incision disclosed the mass previously noted occupying the root of the mesentery of the terminal ileum. It was the size of a small orange, hard, nodular, with local lymph node involvement. The intestines were agglutinated to it and in one area were compressed. In view of the fact that the nature of the lesion could not be decided upon and that it was compressing the lumen of the bowel, a resection was performed. This necessitated a wide removal of the terminal ileum. The resection reached the most distal portion of the ileum so that an end-to-end anastomosis was impractical. A side-to-side ileotransverse colostomy was, therefore, accomplished, and an ileostomy of the Witzel type was added in the ileum proximal to the anastomosis. The tube was brought out through the lower angle of the incision. The wound was closed in layers.



FIG. 1.—Gross specimen of resected ileum with large, inflammatory tumor of the mesentery.

Pathologic Examination.—Gross.—The specimen (Fig. 1) consisted of 46 inches of intestine with its mesentery. A large mass occupied the root of the mesentery. The mass measured about 8 cm. in diameter and was globular. It was firm, well defined, and on section revealed normal fat tissue traversed by numerous interlacing dense white strands of fibrous tissue, and was hemorrhagic in places. Normal vessels, with unstricted lumina, were seen coursing through the mass. In its periphery a few small fleshy nodes of lymphoid tissue were noted. The mesentery to the right and left of this mass was markedly shortened by adhesions; this folded, thickened mesentery was firmly adherent to one face of the mass. The mesentery of the central portion of resected bowel approximated the normal length and presented large hemorrhagic areas. This fore-shortened mesentery at each end of the resected ileum converted the entire length of bowel into a large horseshoe shaped loop; the bowel itself, as it surrounded the tumor, was thrown into numerous coils. The serosal surface of the ileum was

hemorrhagic. The opened ileum revealed a perfectly intact mucosa. No fistulous tracts were demonstrable.

Microscopic Diagnosis.—Fibromatous, chronic inflammatory mesenteric tumor.

Postoperative Course.—The ileostomy tube drained well almost immediately after operation. It was clamped off after a period of ten days, following which patient's bowels functioned normally. The wound healed by primary union except for a small amount of suppuration at the upper angle where a dam had been inserted at the time of operation. Patient was discharged well, 24 days after operation.

OBSTRUCTION DUE TO APPENDICES EPIPLOICAE

CARL BAUMEISTER, M.D.,

COUNCIL BLUFFS, IOWA

C. W. HARGENS, M.D. AND C. F. MORSMAN, M.D.

HOT SPRINGS, S. DAK.

REPORTED cases of obstruction of the intestine by means of constriction by two appendices epiploicae becoming adherent across its antemesenteric surface are rare. In 1924, Klingenstein¹ reviewed all of the known cases. There had been but three instances of this complication recorded. In 1933, Patterson⁴ reported that there had been but two other cases occurring in the intervening years. In 1933, McIver⁶ mentioned that the appendices epiploicae may also act as an obstructive band by becoming attached through inflammatory processes. He added an additional case. There are, therefore, only five reported cases of intestinal obstruction due to adherent appendices epiploicae. To this list we wish to add a sixth instance.

Case Report.—J. K., a very obese male, age 62, entered the Sisters Hospital at Hot Springs, South Dakota, March 13, 1937, complaining that he had had no bowel movement since March 9. Four days before he came under our care, his abdomen had begun to become distended, which was accompanied by generalized abdominal pains, and he had vomited twice on the day of onset, since which time he had only been able to pass a small amount of flatus and a little stool which had the appearance of soap water. The abdomen had become swollen to tremendous proportions. He had been becoming increasingly constipated during the preceding four months, and had had, occasionally, bright red blood in his stool during that time. He had lost eight pounds, in weight in the past few months. He had never had a hernia, but had had an appendectomy 11 years ago. His appetite had always been inordinate.

Examination.—Showed four plus distension of the abdomen, and the right rectus abdominis scar. The bowel sounds were not distinct, and there could be heard an occasional tinkling. Rectal examination did not reveal any masses but showed some large internal hemorrhoids. Examination was otherwise negative except for the presence of marked obesity. **Diagnosis:** Acute mechanical obstruction of the large bowel, probably due to carcinoma of large bowel with probably secondary paralytic ileus (early). (One of us mentioned the possibility of the blood per rectum being due to hemorrhoids and the obstruction to adhesive bands.)

Operation.—A tremendously distended large and small bowel was disclosed. A cecostomy was performed. The source of obstruction was not ascertained. The patient was only slightly relieved by the operation. He developed a complete secondary paralytic ileus, and bubbling râles in his chest. There ensued a peripheral vascular failure

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with rapid pulse, the heart finally becoming markedly irregular, with a rapid fall in blood pressure before his exitus, March 18.

Final Diagnosis.—Primary cause of death: Acute colonic obstruction with secondary paralytic ileus. Secondary or immediate cause of death: Acute cardiac failure following a peripheral vascular failure (etiologic factor of this bronchopneumonia and paralytic ileus). Contributory cause: Extreme obesity.

Autopsy.—(Three hours after death). *Peritoneal Cavity:* There was no free fluid present. The peritoneum, except in the right lower quadrant, was smooth and shiny, there being no engorgement of blood vessels or exudate visible. Entering the cecum was a rubber drainage tube. Around the cecum was an abscess cavity with walls about 1 cm. thick. The external surface of the abscess cavity had moist, yellowish, moderately easily separable adhesions between it and the omentum. On breaking into the abscess cavity, about 160 cc. of greenish yellow, moderately thick, very foul *B. coli* pus were found. The adhesions surrounding the cavity were principally lateral and inferior. The general peritoneal cavity did not appear to be contaminated. The liver border was 2.2 cm. below the ensiform cartilage and 4.5 cm. below the costal margin.

Large Intestine.—As the large intestine ascended from its junction with the rectosigmoid there were a number of constrictions across its anterior surface. These were caused by adhesions between appendices epiploicae which were located on opposite sides of the gut. They were not diverticula. The first one of the constrictions between adherent appendices epiploicae was at a point 17.3 cm. above the rectosigmoid junction. The bowel below this point was not distended. Above this point the gut was distended for 18 cm., but was of fairly good color. This was followed by another adhesion between two appendices epiploicae. Then came a portion of gut 17.7 cm. in length which was not distended, at the proximal end of which there was another adhesion between two appendices epiploicae. Proximal to this last adhesion between the appendices epiploicae there was distention of the entire gut including the duodenum and stomach. This collapsed loop of large gut between the two constrictions was an interesting example of a blind collapsed loop with obstruction at either end.

Small Intestine.—This was uniformly greatly distended. Portions of the lower ileum and the beginning of the jejunum had a mottled, purplish color. There was no distinctly gangrenous gut. There were no perforations apparent.

Discussion.—This case presented an interesting problem in differential diagnosis. It was another example of the fact that two pathologic entities, *i.e.*, hemorrhoids and adhesive bands, can cause bleeding per rectum and intestinal obstruction, as do the much more commonly occurring neoplasms of the rectosigmoid.

REFERENCES

- ¹ Klingenstein, Percy: Some Phases of the Pathology of Appendices Epiploicae with Report of Four Cases and Review of the Literature. *Surg., Gynec. & Obstet.*, **38**, 376, 1924.
- ² Hunt, V. C.: Torsion of Appendices Epiploicae. *ANNALS OF SURGERY*, **69**, 31-46, 1919.
- ³ Riedel: Ueber die Drehung der Appendices Epiploicae und ihre Folgen (Unpora Aliens und Strainge im Bauche). *Munchen. Med. Wehnschr.*, **52**, 2308-2311, 1905.
- ⁴ Patterson, Daniel C.: Appendices Epiploicae and Their Surgical Significance, with Report of Three Cases. *New Eng. Jour. Med.*, **209**, No. 25, 1255-1259, December 21, 1933.
- ⁵ Hamilton, Thos.: Two Cases of Torsion of an Appendix Epiploicae. *Med. Jour. Australia*, **1**, No. 22, 773, May 28, 1932.
- ⁶ McIver, M. A.: Acute Intestinal Obstruction. *Amer. Jour. Surg.*, **19**, 163-206, January, 1933.

GUNSHOT WOUND OF RIGHT ILIAC BONE *

COMPLICATED BY UNCONTROLLABLE SINUSES OF RIGHT GLUTEAL REGION

SIGMUND MAGE, M.D.

NEW YORK, N. Y.

Case Report.—An Italian, age 41, received on January 29, 1916, a gunshot wound of the lower abdomen; the bullet traversed the right iliac fossa and pierced the right iliac bone. An immediate abdominal exploration was performed at the Volunteer Hospital, New York City, the findings of which we have never been able to ascertain.

Two days later the bullet was removed from the subcutaneous tissues of the right gluteal region, through an incision which remained the site of a persistent draining sinus. He apparently was free of any discomfort until December, 1926, when he was admitted to the Beekman Street Hospital for the incision and drainage of a large right gluteal abscess, which seemed to originate in the region of a defect in the iliac bone created by the bullet (Fig. 1). Ever since then he has been under more or less continuous observation for recurrent abscesses and an increasing number of draining sinuses. His hospital admissions were December, 1926; July, 1929; March, 1931; September, 1932; January, 1933; and finally April, 1935.

All efforts to control the spread of the infection or to discover its cause have been unsuccessful. On two occasions the defect in the ilium was fully exposed and found to be a clean cut, rigid walled opening, without evidence of acute infection in the surrounding bone—curettings from which merely revealed a very low grade osteitis. No foreign body was discovered. Repeated cultures of the discharge from sinus tracts usually returned a gram-negative bacillus of the *B. coli* group. Anaerobic cultures were negative. There was never any clinical or roentgenologic finding of a gastrointestinal origin. Tuberculosis and mycotic infections were suspected and sought without result.

Although the patient's general condition did not suffer materially, he was economically incapacitated because of the local condition. On his last admission in April, 1935, there were at least 70 sinuses distributed over the right gluteal area, extending posteriorly to the left lumbar region and anteriorly to the right iliac fossa (Fig. 3A and B). It was then felt that two possible factors for the persistence of the infection had to be eliminated: (1) A foreign body on the inner aspect of the iliac bone. (2) The defect in the iliac bone, inasmuch as the recurrent abscesses and sinuses seemed to originate in or about its site. It was decided that removal of a segment of ilium, which included the defect, might accomplish both these objectives.

Operation.—April 27, 1935: An incision was made along the crest of the right ilium, extending from the anterior superior to the posterior superior iliac spine, mobilizing the gluteal muscles. A triangular segment of bone, 10 cm. at its base, $2\frac{1}{2}$ cm. at its apex and $7\frac{1}{2}$ cm. on its side, was excised (Fig. 2). Grossly, it showed nothing remarkable, and microscopic examination revealed only a very low grade osteitis with more of a tendency to a reparative reaction than an inflammatory one. The underlying psoas-iliacus muscles showed considerable fibrotic changes, but no sinus tracts were noted extending inwardly and no foreign body was found. The exposed area was packed and allowed to granulate.

The many sinus tracts, which literally honey-combed the gluteal muscles and which in themselves were possible factors for the persistence of the infection, were destroyed by a number of subsequent procedures, in which all detectable tracts were fully exposed, cauterized and then allowed to granulate from below up. The patient

* Presented before the New York Surgical Society, February 24, 1937. Submitted for publication May 22, 1937.



FIG. 1.—Roentgenogram showing the defect in the right iliac bone created by the bullet.



FIG. 2.—Postoperative roentgenogram drawing the extent of the wedge-shaped resection of the right iliac bone.



FIG. 3.—(A) Photograph, prior to resection of the right iliac bone, showing the posterior appearance of the multiple draining sinuses. (B) Lateral view.

GUNSHOT WOUND OF ILIAC BONE

was discharged to the O.P.D. September 14, 1935, after a hospitalization of 142 days, with extensive granulating wounds which were finally healed by July, 1936 (Fig. 4A and B). We had thought we had effected a temporary arrest of the infection because, for the first time in 21 years, the patient had gone for a period of over six months with all the sinuses completely healed. Examination, February 24, 1937, however, revealed a recurrence of activity and we are presenting the case for interpretation of the pathology and for advice as to future therapy.

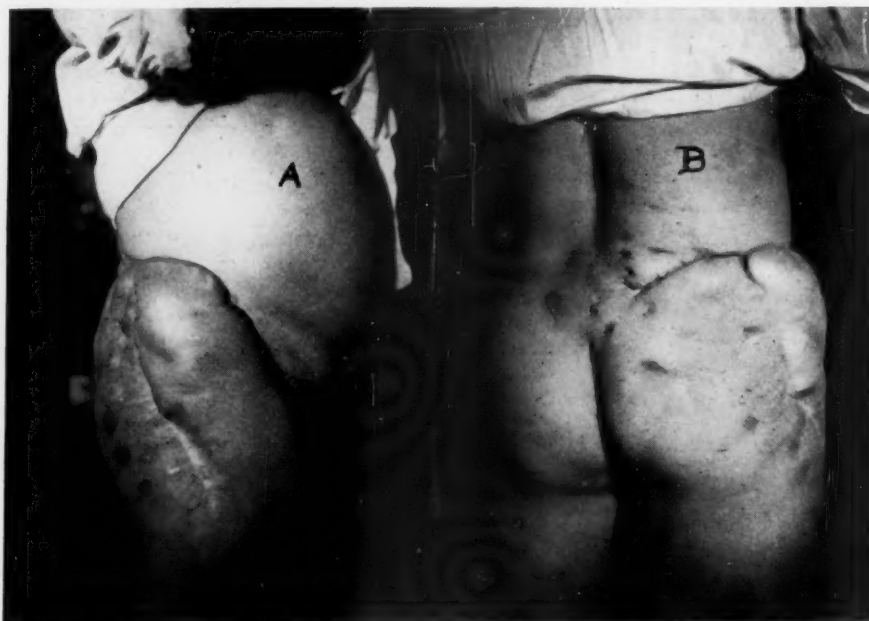


FIG. 4.—(A) Photograph, subsequent to resection of the right iliac bone, showing the lateral appearance of the right hip after the sinus had healed. (B) Posterior view.

While the clinical behavior of this case may be characteristically that of an osteomyelitis of the iliac bone, its mode of onset, gross, microscopic and roentgenologic findings have not been so. The microscopic sections have shown a very low grade of osteitis, characterized by occasional collections of mononuclear cells and a distinct tendency toward repair rather than activity. The evidence of a bone infection has been most meager and certainly not in proportion to the clinical manifestations. On the theory that the defect caused by the bullet might have mechanically been responsible for keeping up a low grade infection, we attempted a radical extirpation of the bone about that area. A complete iliectomy may be necessary, on the basis of the available evidence, but it is difficult to see any particular reason for a more hopeful outcome resulting from that procedure. Despite most careful and thorough search, it is conceivable that this condition may still be dependent upon an undetected foreign body. However, we do not feel justified in further extensive investigation unless that possibility becomes more tangible.

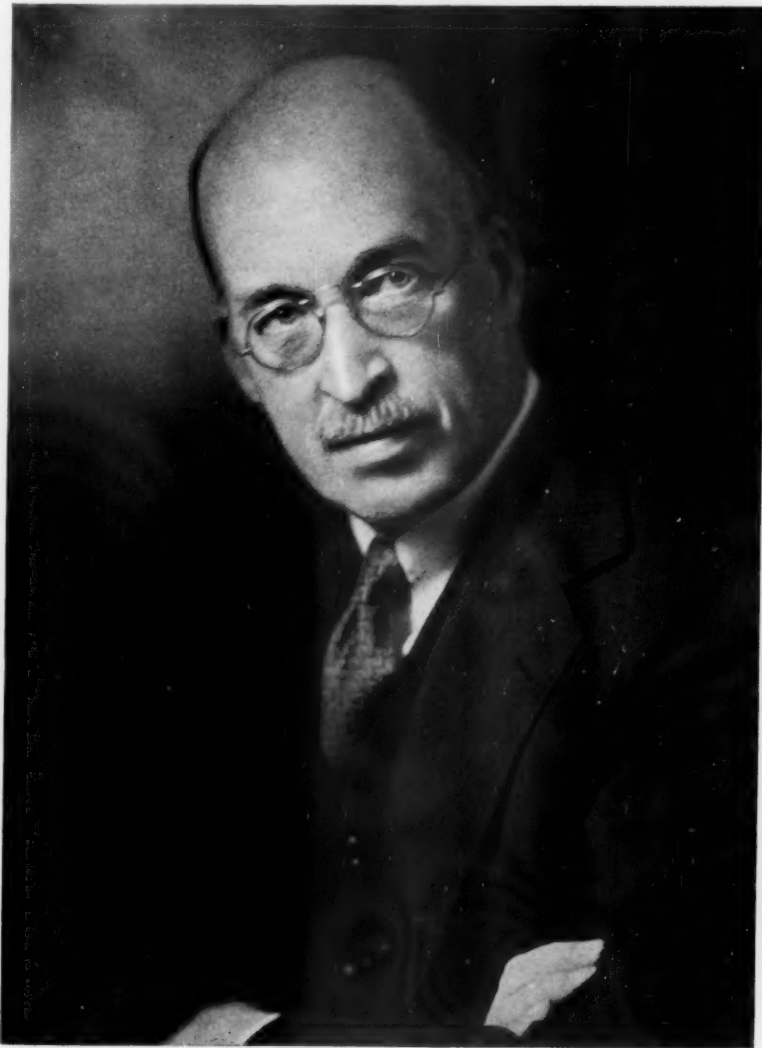
DISCUSSION.—DR. ROBERT H. KENNEDY (New York) stressed the importance of Doctor Mage's case of chronic osteomyelitis of the ilium from the economic point of view. The patient has been under hospital treatment for 21 years. At first, when he presented himself at Beekman Street Hospital 11 years ago, it seemed simple to make a diagnosis: Osteomyelitis from an old gunshot wound. However, this was not verified by the roentgenologic findings. It was thought that a foreign body might be present and this possibility was investigated. No foreign body was found. A vain search was made for actinomycosis, tuberculosis, and even for a foreign body in the abdomen. The patient developed one sinus after another. Then Doctor Mage decided that infection was being kept up because there was a rigid cavity. He tried to take away some of the rigidity by resecting bones. The pathologist could report only osteitis. Doctor Kennedy was not quite convinced that there was sufficient evidence to justify removing the rest of the flare of the ilium which was done rather recently, but whether this be so or not, one point was brought out. When there is an osteomyelitis, it is important in the early stages to perform just as radical a procedure as may seem necessary, in the hope of earlier cure.

MEMOIR

FRANCIS ALEXANDER CARRON SCRIMGER

1880-1937

THE American Surgical Association desires to give expression to its deep sense of loss in the death of Dr. Francis Alexander Carron Scrimger, V.C.,



FRANCIS ALEXANDER CARRON SCRIMGER, M.D.

of Montreal, who died suddenly on February 13, 1937, in his fifty-seventh year, of coronary thrombosis. He had been a member of this Association since 1930.

Educated at McGill University, where he received his B.A. degree in 1901, and his medical degree in 1905, Doctor Scrimger started his postgraduate training in the Royal Victoria Hospital, where he was for three years an intern in the Departments of Medicine and Surgery, and then studied in Europe for a year, principally in Dresden and Berlin. Upon his return to Montreal he was appointed to the surgical staff of the Royal Victoria Hospital, where he soon gave evidence of his excellent clinical knowledge and of the investigative spirit which always characterized his surgical career.

When war broke out he was appointed Medical Officer to the 14th Battalion, and left with the first contingent from Canada. While in charge of a field dressing station at the second battle of Ypres he was awarded the Victoria Cross for distinguished bravery. Later he served at the base with the Canadian General Hospital No. 1, at Étaples, then with the Granville Hospital, in England, and again in charge of the McGill Unit, No. 3 Canadian General Hospital, at Boulogne, with the rank of Lieutenant-Colonel. His war service lasted nearly five years. Upon demobilization he returned to Canada and rejoined the staff of the Royal Victoria Hospital. His career from that time on was one of steady, quiet advance along clinical lines, and resulted in several important achievements in research. In 1936, he was appointed Chief Surgeon to the Hospital, and Associate Professor of Surgery at McGill University.

Doctor Scrimger possessed a great capacity for friendship and had a wide circle of close friends. He was particularly valued as a consultant by his medical confreres because of his wide knowledge, his diagnostic ability, his general soundness and clearness of view, and his unusual skill as an operator.

On this continent and in the Old Country he had many friends and was known as one of Canada's outstanding surgeons. This reputation was recognized by his election to membership in the most important surgical societies of this continent, among them the American College of Surgeons, the American Association for Thoracic Surgery, the International Society of Surgery, the Interurban and the Halsted Societies.

We, his confreres in the American Surgical Association, wish to record our very real sorrow at his death.

EDWARD W. ARCHIBALD.

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